ASSESSING SOUTH CAROLINA'S OCEAN ECONOMY

2020 REPORT BY THE S.C. SEA GRANT CONSORTIUM

S.C. SEA GRANT CONSORTIUM
Coastal Science Serving South Carolina

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EXECUTIVE SUMMARY

Economic activity can be measured through several different indicators and through several different methods. Depending on the interest, one can use jobs, spending, income, investment, economic impact (input-output) analysis, gross domestic product (GDP), or non-market valuation to characterize economic activity. Further, the way economists measure economic activity related to coastal and ocean environments can vary as well. Measuring things like the coastal economy GDP (total GDP in coastal counties), the ocean economy GDP (total GDP associated with production that takes place on the ocean or marginal seas, receives essential inputs from the ocean or marginal seas, takes place near the ocean or marginal seas by necessity, and production of commodities purchased for use on the ocean or marginal seas), and non-market ecosystem service benefits (estimating values for environmental attributes that do not typically have prices associated with them) all lend context to the economic benefits provided by coastal and ocean resources, both natural and cultural.

In 2018, South Carolina's eight coastal counties produced $66.58 billion in nominal GDP, 28% of the state total. In terms of employment, 585,909 people worked in the coastal counties with an additional 122,522 self-employed workers, representing 29% of the state total (National Ocean Economics Program [NOEP], 2018; US Census Bureau, 2019a). Furthermore, within these coastal counties, tens of thousands of jobs and billions of dollars in GDP are derived from the state's coastal and ocean natural resources. These natural resources make several things possible: tourism and recreation opportunities, commercial and recreational fishing, energy generation, transportation, and other important activities; benefiting humans tangibly by creating jobs and generating business revenue, as well as intangibly by providing a way of life and a social connection to place, all of which contribute to the state's robust ocean economy.

The ocean economy is a smaller subset of the total economy of South Carolina's coastal counties, consisting of the following six ocean sectors: marine construction, living resources, offshore mineral extraction, ship and boat building, tourism and recreation, and marine transportation. The most recent available data from 2017 indicate that South Carolina's ocean economy provided jobs for 3.5% of state residents (12.2% of coastal county residents), and produced 2.1% of the state's GDP (7.6% of GDP in the coastal counties) in 2017 (National Oceanic and Atmospheric Administration Office for Coastal Management [NOAA OCM], 2020a).

Within the ocean economy, the tourism and recreation ocean sector contributes $3.86 billion to state GDP (6.2% of total coastal county GDP; 1.7% of state GDP), accounting for 87.0% of total ocean economy employment (including self-employed workers) and 80.7% of ocean economy GDP. This indicates that the tourism and recreation sector is driving much of South Carolina's ocean economy. Since the end of the Great Recession of 2007-2009 (using 2009 as a baseline year), South Carolina's ocean economy in real dollars has grown 53% as of 2017, compared to just 22% for the state of South Carolina as a whole (NOAA OCM, 2020a; US Bureau of Economic Analysis [BEA], 2019b). This suggests that the ocean economy has been of great importance in South Carolina's recovery from the recession.

The data reported in Figure ES-1 can be considered conservative estimates for the total economic benefits provided by the ocean economy, as other values derived from coastal and ocean resources that contribute to the state's economy are not captured, such as coastal development driven by coastal amenities, and other ecosystem services produced by coastal habitats.

Figure ES-1: South Carolina's Ocean Economy, 2017

The data in Figure ES-1 provide necessary context for assessing the status and trends of South Carolina's ocean economy. However, in order to examine other market and non-market economic benefits derived from coastal and ocean resources, additional data will be presented in this report to expand upon the information provided by NOAA OCM. While NOAA OCM tracks establishments, employment, wages, and GDP associated with ocean economy sectors, it is important to examine other indicators of economic activity attributable to coastal and ocean natural resources utilizing data collected by South Carolina state agencies and other entities and researchers through a variety of methods. For example, $38.68 billion worth of exports and $51.58 billion worth of imports passed through South Carolina's ports in 2019 (US Census Bureau, 2019c); visitors in South Carolina's coastal counties spent $9.13 billion in 2018 (United States Travel Association, 2019); marine recreational fishers in South Carolina spent $779.93 million in 2017 (NOAA National Marine Fisheries Service, 2020a); commercial fishery dockside revenue in South Carolina was $22.78 million in 2019 (South Carolina Department of Natural Resources, 2020a); and wetland habitats in South Carolina are estimated to provide coastal protection benefits of over $3.9 billion per year (Sun and Carson, 2020).[1]

South Carolina's coastal ecosystems and the natural, cultural, and historic resources contained within them contribute to the character of the state and the lifestyle of its residents. The state's expansive system of open ocean, beaches, sand dunes, wetlands, tidal creeks, estuaries, and oyster reefs are also of great economic importance. Given that coastal and ocean natural resources inherently underpin the economic activity associated with the ocean economy, maintaining the health of these resources will be important for sustaining and growing the ocean economy. Moreover, it is important to preserve and maintain the activities and resources that contribute historic and cultural value to South Carolina's ocean economy, such as the Gullah Geechee Cultural Heritage Corridor, ferries to Fort Sumter, and the historic architecture that attracts visitors to Charleston, Beaufort, and other coastal towns. With proper resource management and monitoring of ocean economy sectors, South Carolina has the potential to benefit from a sustainable Blue Economy, a concept defined as "when economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy."

[1] All data have been inflation-adjusted to year 2017 dollars.

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INTRODUCTION

As hunter-gatherers began to settle into communities, all early settlements of human populations were adjacent to waterbodies. Whether along a coast, a river, or an estuary, these early humans chose to settle along the water for the bounty of resources that waterbodies provide. Waterbodies provided a source of food and a means of transportation, while also becoming culturally integrated into the human experience. In modern times, humans still reside adjacent to waterbodies, continuing to rely upon them for a variety of subsistence resources and economic opportunities. When focusing on coastal areas, an estimated 2.4 billion people (40% of the world's population) live within 100 kilometers of a coast; a population density twice the global average (United Nations, 2017).

The National Oceanic and Atmospheric Administration (NOAA) has recently developed an Ocean Economy Satellite Account (OESA) in partnership with the United States (US) Bureau of Economic Analysis (BEA) to measure annual ocean economy activity. For the purposes of this OESA, the ocean economy has a geographic scope of all U.S. oceans and marginal seas. This comprises the Atlantic, Pacific, and Arctic oceans within the Exclusive Economic Zone, as well as marginal seas such as the Gulf of Mexico, Chesapeake Bay, Puget Sound, and others. Also included is the U.S. shoreline directly along these bodies of water, and portions of inland waters where there is significant marine activity (US BEA, 2020). In addition to geography, the ocean economy is further defined as production taking place in the following three categories (US BEA, 2020):

1. Production from the waters that are geographically in-scope. Included in this category is any production that takes place on the ocean or which receives essential inputs from the ocean (e.g., water freight transportation, offshore oil and gas extraction, and commercial fishing).
2. Production that, by necessity, takes place near the ocean (e.g., coastal recreation and beach house rentals). The ocean/coastal relationship of these production activities are identified and measured by geographic location in a shore-adjacent ZIP code area.
3. Commodities purchased for use on the ocean, no matter where production takes place (e.g., ship and boat building, marine navigation equipment). Other production in this category may be for a variety of uses, such as foul-weather gear and diesel fuel, but only ocean-specific uses tied to the geographically relevant region are considered in scope for the ocean economy statistics.

Prototype OESA statistics released in June 2020 indicate that in 2018 at the national level, the ocean economy contributed $372.84 billion in nominal gross domestic product (GDP), $617.19 billion in nominal gross output, 2.28 million jobs, and $161.95 billion in nominal wages. This accounts for 1.8% of national GDP, and represents a nominal increase of 5.8% in ocean economy GDP since 2017, a growth rate faster than the national average increase of 5.4% (NOAA, 2020). Measuring and assessing the size and trends of the ocean economy allows decision makers to evaluate economic activity in ocean economy sectors relative to other sectors like manufacturing, finance, and textiles. If the ocean economy is not considered by decision makers, there is risk in missing opportunities to foster collaboration between ocean economy sectors, and in missing opportunities to develop a coordinated policy vision for supporting sustainable economic growth (Edwards et al., 2014).

These figures suggest that the ocean economy has burgeoning sectors with substantial economic growth

potential. Balancing this economic growth potential with sustainability and resilience will be the key in order to transition to a sustainable Blue Economy, a concept defined as "when economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy" (Economist Intelligence Unit, 2015).

South Carolina's ocean and coast provide its residents and visitors with food, jobs, energy sources, recreation opportunities, shoreline protection, and aesthetic beauty, among other ecosystem services. The South Carolina coast has been inhabited by humans for at least approximately 4,300 years, as suggested by the Pockoy Island Shell Rings within the Botany Bay Plantation Heritage Preserve on Edisto Island (South Carolina Department of Natural Resources [SCDNR], 2019). In modern times, people that live in and visit South Carolina derive value from, and contribute to, the state's ocean economy by enjoying the history and scenic beauty of coastal cities like Charleston and Beaufort, participating in the beach recreation activities at coastal tourist destinations like Myrtle Beach, and by fishing, hunting, and consuming seafood along the entire coast. With more human population growth forecasted, there is a need to meet the food, energy, and health demands of this growing population. Increasingly, additional industries beyond just fisheries with multiple, sometimes overlapping, uses are being investigated as viable economic opportunities to meet this demand, including fish and shellfish aquaculture, marine pharmaceuticals, and offshore renewable energy (Spalding, 2016; Economist Intelligence Unit, 2015). South Carolina's ocean economy is dependent upon, and can impact, the health of the state's coastal and ocean natural resources, highlighting an important link between marine ecosystem conservation and a sustainable ocean economy.

South Carolina's Coastal Population

South Carolina has 46 counties, eight (Horry, Georgetown, Berkeley, Charleston, Dorchester, Colleton, Beaufort, Jasper) of which are coastal (Figure 1), representing 23% of the state's land area. Similar to the global trend, South Carolina's coast has experienced substantial population growth as well (Table 1).

Overall, South Carolina's coastal county population has increased 116% from 1980-2019, from roughly 686,000 residents to almost 1.48 million residents. All of the coastal counties have experienced population growth since 1980, with five of the counties (Beaufort, Berkeley, Dorchester, Horry, and Jasper) more than doubling in population size over this time frame. Further, all but one (Colleton County) have experienced population growth since 2000, with some county populations having grown by more than 50% (Berkeley, Beaufort, Dorchester, Horry) in this time frame. In 2019, residents in the eight coastal counties accounted for 29% of total state residents. Population density is higher along the coast as well at 216.71 persons/square mile in the coastal counties, compared to 157.94 persons/square mile in non-coastal counties (US Census Bureau, 2019b). The assessed market value of residential property (e.g., homes, apartments, condos, townhomes, mobile homes, duplexes, etc.) in the coastal counties of Beaufort, Berkeley, Charleston, Dorchester, Georgetown, and Horry is over $95.2 billion (year 2017 dollars, Motallebi and Ureta, 2019).[2] Most of these residential homes (72% of all housing units in the eight coastal counties) have been built since 1980 (US Census Bureau, 2018), lending further context to the substantial changes in human activity in coastal

[2] Data for Jasper and Colleton counties were unavailable at the time of this report; therefore, the true value of residential properties in all eight of South Carolina's coastal counties is expected to be greater than $95.2 billion.

South Carolina over the last 40 years. While residents of the coastal counties are most closely tied to the ocean economy, communities in South Carolina in the midlands and the upstate also depend on the ocean for a variety of services like seafood, the transportation of goods, and recreational opportunities.

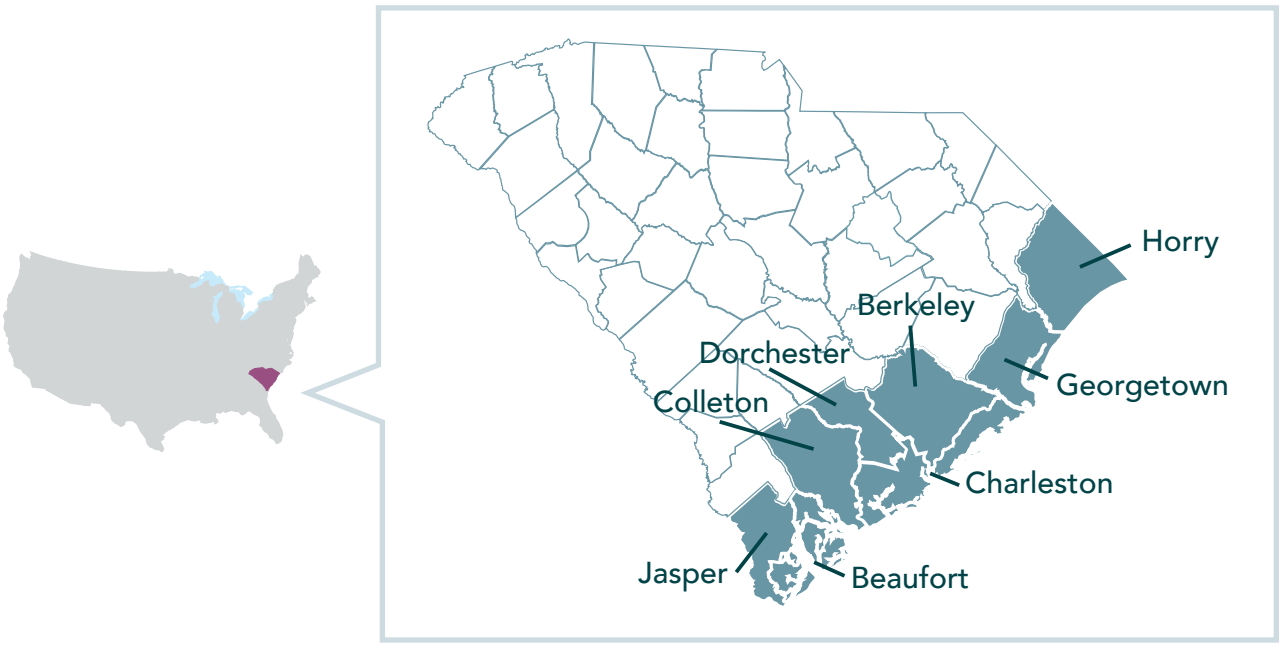


Figure 1: Coastal Counties in South Carolina

Table 1: South Carolina Coastal County Population Trends

Year	Beaufort	Berkeley	Charleston	Colleton	Dorchester	Georgetown	Horry	Jasper	TOTAL
1980	65,364	94,727	276,974	31,776	58,761	42,461	101,419	14,504	685,986
1990	86,425	128,776	295,039	34,377	83,060	46,302	144,053	15,487	833,519
2000	120,937	142,651	309,969	38,264	96,413	55,797	196,629	20,678	981,338
2005	141,498	153,489	331,589	38,728	113,235	59,521	229,899	21,845	1,089,804
2010	162,233	177,843	350,209	38,892	136,555	60,158	269,291	24,777	1,219,958
2015	171,420	193,613	372,904	38,004	145,715	60,572	290,730	26,549	1,299,507
2019	192,122	227,907	411,406	37,677	162,809	62,680	354,081	30,073	1,478,755
% Change 2000-2019	59%	60%	33%	-2%	69%	12%	80%	45%	51%
% Change 1980-2019	194%	141%	49%	19%	177%	48%	249%	107%	116%

Source: US Census Bureau: Decennial Census, American Community Survey 5-year estimates, Annual Estimates of the Resident Population.

MEASURING SOUTH CAROLINA'S OCEAN ECONOMY

Economic activity can be measured through several different indicators and methods. Depending on the interest, one can use jobs, spending, income, investment, economic impact (input-output) analysis, GDP, or non-market valuation to characterize economic activity. Further, the way economists measure economic activity related to coastal and ocean environments can vary as well. Measuring parameters like the coastal economy GDP (total GDP in coastal counties), the ocean economy GDP (total GDP associated with production that takes place on the ocean or marginal seas, receives essential inputs from the ocean or marginal seas, takes place near the ocean or marginal seas by necessity, and production of commodities purchased for use on the ocean or marginal seas), and non-market ecosystem service benefits (estimating values for environmental attributes that do not typically have prices associated with them) all lend context to the economic benefits provided by South Carolina's coastal and ocean resources, both natural and cultural. The purpose of this report is to provide an overview of South Carolina's ocean economy based on available data; expand upon information provided by NOAA OCM to examine other market and non-market economic benefits derived from coastal and ocean resources; identify ocean economy sectors for potential future growth; and discuss how natural resource health provides a foundation for economic activities along South Carolina's coast.

Notes and Caveats

Terminology

Various terms are used throughout this report to detail the economic benefits of South Carolina's ocean economy. These terms are defined below.

- **Coastal Economy** – total economic activity in coastal counties (National Ocean Economics Program [NOEP], 2018).
- **Ocean Economy** – total economic activity associated with production that takes place on the ocean or marginal seas, receives essential inputs from the ocean or marginal seas, takes place near the ocean or marginal seas by necessity, and production of commodities purchased for use on the ocean or marginal seas (NOAA, 2020).
- **Blue Economy** – a concept defined as when economic activity derived from the ocean is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy (Economist Intelligence Unit, 2015).
- **Economic Value** – a monetary metric of value derived from a given sector. It can be measured through consumer surplus (the maximum price or amount of money that someone is willing to pay for a good or service minus its market price) and producer surplus (the market price of a good or service minus the minimum amount the producer is willing to accept). As a result, economic value can be higher than market value (Harrison, 2017).
- **Market Value** – the value of goods and services based on their market prices (International Valuation Standards Council, 2020).
- **Economic Impact** – net changes in new economic activity associated with an industry, event, or policy in an existing regional economy (Watson et al., 2007). Total economic impact is comprised of direct, indirect, and induced effects, and is measured by employment (full-time and part-time jobs), personal

income, output (business sales), and value-added (contribution to GDP).

- **Economic Contribution** – the gross changes in economic activity associated with an industry, event, or policy in an existing regional economy (Watson et al., 2007). Economic contributions are also measured through employment (full-time and part-time jobs), personal income, output (business sales), and value-added (contribution to GDP). It is comprised of direct effects, and may include related indirect and induced effects.
- **Direct Effects** – the results from expenditures associated with a given economic sector (Willis and Straka, 2017). For example, tourists spend money on hotels, food, and fishing trips at local businesses.
- **Indirect Effects** – the results of business-to-business transactions indirectly caused by the direct effects. Businesses initially benefiting from the direct effects will subsequently increase spending at other local businesses. The indirect effect is a measure of this increase in business-to-business activity (Willis and Straka, 2017).
- **Induced Effects** – the results of increased personal income caused by the direct and indirect effects. Businesses experiencing increased revenue from the direct and indirect effects will subsequently increase payroll expenditures (by hiring more employees, increasing payroll hours, raising salaries, etc.). Households will then increase spending, including at local businesses. The induced effect is a measure of this increase in household-to-business activity (Willis and Straka, 2017).
- **Gross Domestic Product (GDP)** – the total market value, measured at the point of final demand, of all goods and services produced within a given economy over a given time, less the value of goods and services used in production (Harrison, 2017).

It is especially important to be aware of the differences in results derived from economic impact analysis (EIA; net changes in new economic activity) and results derived from economic contribution analysis (ECA; gross changes in economic activity). Thus, ECA is a tool that estimates how much current or status quo economic activity is associated with a certain industry in a regional economy, whereas EIA is a tool that estimates the effects of "injecting new money" into a regional economy (Watson et al., 2007). As a result, estimates derived from ECA should not be aggregated nor compared with estimates obtained from EIA.

Market and Non-Market Benefits

Market-based data (e.g., prices, wages, GDP) are widely available for industries like commercial fisheries and tourism, however there are other coastal and ocean natural resource assets and ecosystem processes that contribute economic benefits to coastal communities and are not typically captured in market transactions. These are referred to as "non-market" benefits, and can include things like coastal protection, carbon storage, water quality, and biodiversity (Figure 2). While the US BEA and the US Bureau of Labor Statistics (BLS) collect annual wage and GDP data for certain ocean economy sectors tracked through markets, comparable data are unavailable for other non-market benefits provided by coastal and ocean resources. These non-market benefits provide value but do not have a market price associated with them. Therefore, non-market economic valuation techniques must be used to estimate their values. It is important to document both market and non-market economic benefits to gain a more holistic understanding of South Carolina's ocean economy.

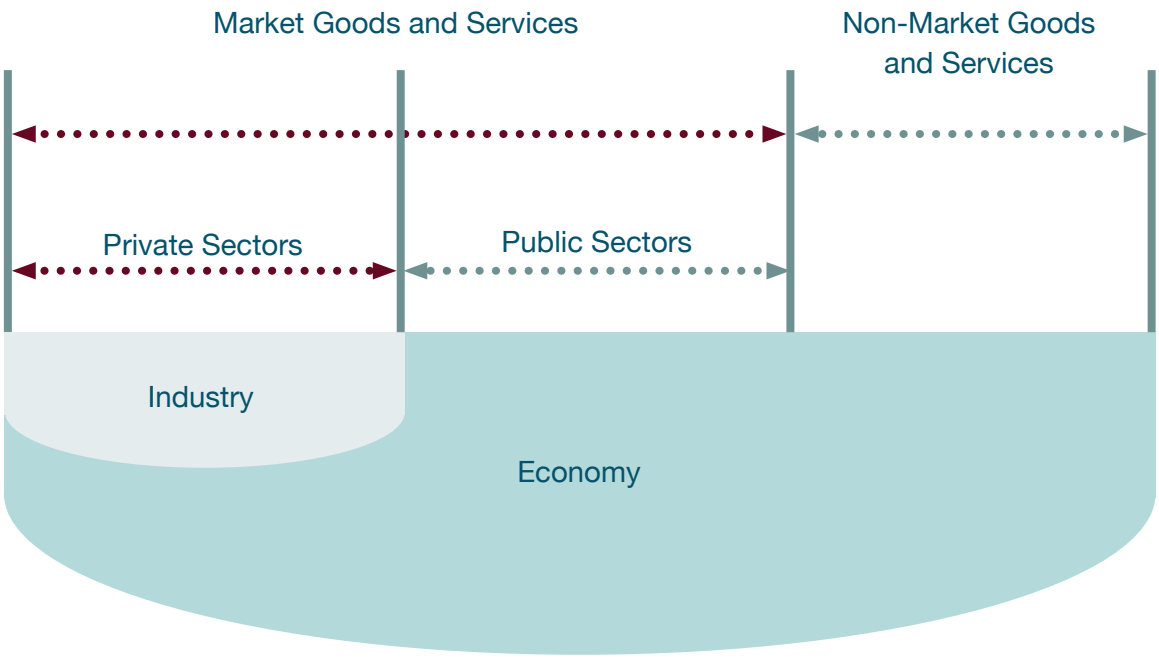


Figure 2: The Ocean Economy Contains Market and Non-Market Economic Benefits (Park and Kildow, 2015)

This report is structured to present the more generalized annual time series data on South Carolina's ocean economy produced by NOAA OCM first, followed by a more detailed examination of ocean economy sectors through additional data sources and studies providing more nuanced information related to industries dependent upon coastal and ocean environments, including commercial fishing, recreational fishing, shellfish aquaculture, tourism, port operations, and ecosystem service production. It is important to note that these additional values, impacts, and contributions provided are, in some cases, not mutually exclusive from the NOAA ocean economy data, nor are they mutually exclusive from one another, and may have also been derived through different methods. Therefore, it is important to note that these additional estimates provided should not be aggregated into the data provided by NOAA, nor should they be aggregated with one another in most cases.

Inflation and Prices

Unless otherwise noted, all dollar values are reported in year 2017 United States Dollars ($USD), adjusted with the Consumer Price Index for all urban consumers (CPI-U) when applicable (US BLS, 2019).

Economics: National Ocean Watch in South Carolina

While the OESA has recently been made available to examine the ocean economy at a national scale, ocean economy trends at the state and county level are tracked by NOAA OCM's Economics: National Ocean Watch (ENOW). The ENOW dataset tracks employment, wage, and GDP trends in marine industries throughout the U.S., utilizing statistics produced by the US BEA and the US BLS that detail the economic contributions of the following sectors: marine construction, living resources, offshore mineral extraction, ship and boat building, tourism and recreation, and marine transportation (NOAA OCM, 2020a).

The types of businesses to include in the above six sectors are determined through an examination of North American Industry Classification System (NAICS) codes (Appendix A). ENOW also tracks self-employed workers that depend on the ocean economy with data from the U.S. Census Bureau's Nonemployer Statistics (NOAA OCM, 2020b; US Census Bureau, 2019a). ENOW data are available for the years 2005-2017, and the trends for South Carolina's ocean economy are described below. A breakdown of these data at the county level in 2017 can be found in Appendix B.

> The tourism and recreation ocean sector contributes $3.86 billion to South Carolina's GDP and employs over 70,000 people in the coastal counties.

In 2017, South Carolina's eight coastal counties produced $62.68 billion in GDP, 28% of the state total. Within the coastal counties, South Carolina's ocean economy (Table 2) consisted of:

- 3,386 establishments
- 81,632 employees, with associated wages of $2.02 billion
- 1,599 self-employed workers, with associated gross receipts of $105.62 million
- $4.78 billion in GDP

Much of this value is driven by the tourism and recreation sector (Figure 3). The tourism and recreation ocean sector in South Carolina's coastal counties employs 71,840 people, with an additional 582 self-employed workers. Including the self-employed workers, this represents 10.6% of total coastal county employment and 3.0% of total state employment (NOAA OCM, 2020a). Additionally, the tourism and recreation ocean sector contributes $3.86 billion to state GDP (6.2% of total coastal county GDP; 1.7% of state GDP). Within the ocean economy itself, tourism and recreation accounts for 87.0% of total ocean economy employment (including self-employed workers) and 80.7% of ocean economy GDP (NOAA OCM, 2020a). This indicates that the tourism and recreation sector is driving much of South Carolina's ocean economy. With such a high reliance on tourism, South Carolina's coastal counties face challenges related to fluctuations in visitors, which can be exacerbated by extreme weather events such as hurricanes, economic downturns that leave people with less discretionary income to spend on recreation, seasonality, and other external factors.

Table 2: South Carolina's Ocean Economy, 2017

Ocean Sector	Establishments	Employment	Wages	Self-Employed Workers	Gross Receipts	GDP
Marine Construction	66	775	$50,744,164	61	$5,646,000	$108,124,600
Living Resources	95	539	$17,245,475	530	$27,782,000	$41,323,094
Offshore Mineral Extraction	22	197	$9,685,121	23	$1,902,000	$24,003,450
Ship and Boat Building	35	2,998	$139,968,575	21	$2,787,000	$244,469,745
Tourism and Recreation	2,983	71,840	$1,541,001,065	582	$47,216,000	$3,856,087,516
Marine Transportation	185	5,283	$264,513,161	382	$20,291,000	$501,835,194
All Ocean Sectors	3,386	81,632	$2,023,157,561	1,599	$105,624,000	$4,775,843,598
Percent of Coastal County Total	9.0%	14.4%	8.4%	1.4%	1.9%	7.6%
Percent of State Total	2.6%	4.0%	2.3%	0.5%	0.7%	2.1%

Note: Columns may not add up to match the figures in the total "all ocean sectors" row. This is due to 1) rounding and 2) confidentiality concerns surrounding publishing business data at smaller scales.

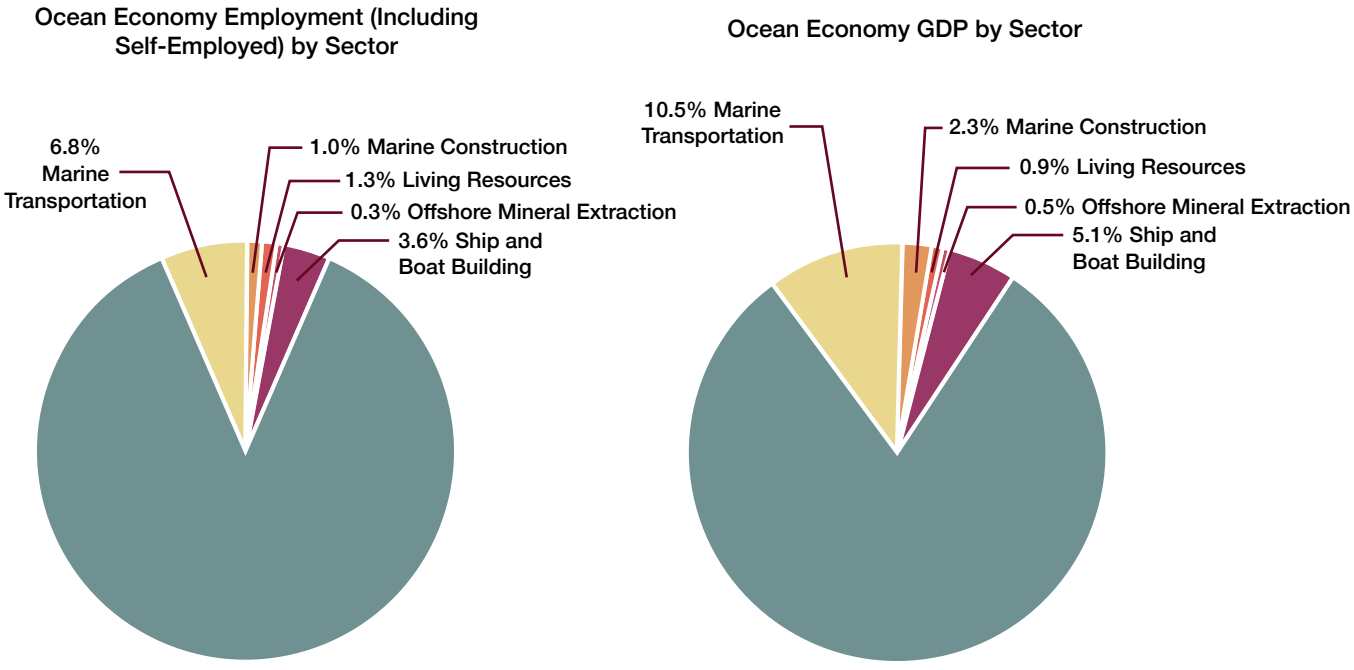


Figure 3: South Carolina Ocean Economy Employment and GDP by Sector, 2017

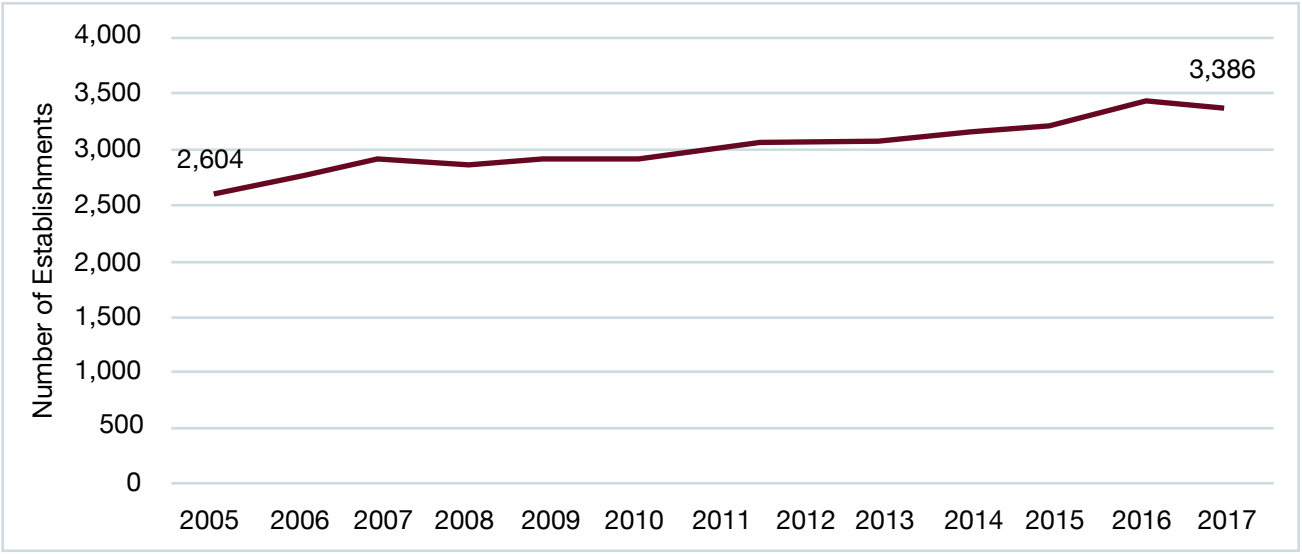


Figure 4: South Carolina Ocean Economy Establishments Trend, 2005-2017

Since 2005, the number of business establishments[3] in South Carolina coastal counties that are involved in the ocean economy has risen 30% from 2,604 in 2005 to 3,386 in 2017 (Figure 4). The rising trend stagnated slightly during the Great Recession of 2007-2009 but has continued to steadily rise since 2010, with a small dip from 2016-2017.

In 2017, these 3,386 establishments represented 2.6% of all business establishments in the state, and 9.0% of all business establishments in the eight coastal counties of South Carolina.

Since 2005, the total number of employees (including those who are self-employed) working in the ocean economy sectors has risen 35%, from 61,867 in 2005 to 83,231 in 2017 (Figure 5, Figure 6, Figure 7). Total employment in the ocean economy has been rising steadily, outside of a small dip during the recession.

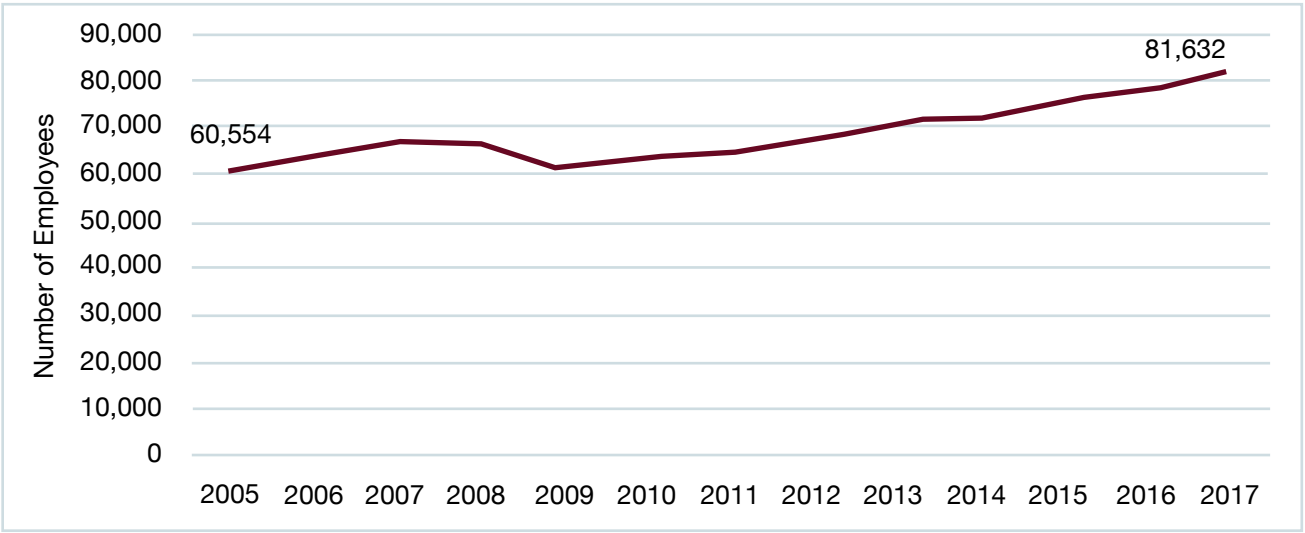


Figure 5: South Carolina Ocean Economy Employment Trend, 2005-2017

[3] An establishment is defined as a business having 2 or more employees.

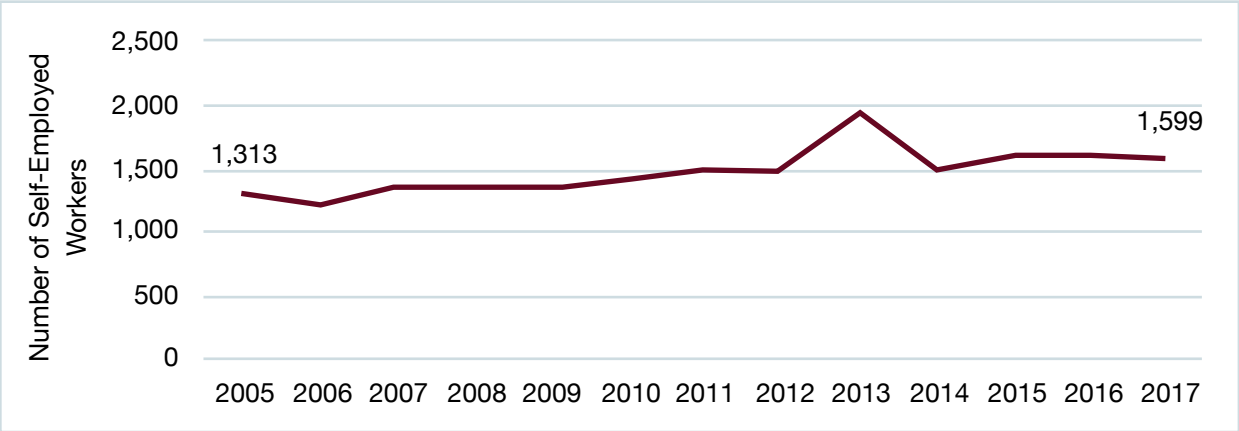


Figure 6: South Carolina Ocean Economy Self-Employed Worker Trend, 2005-2017

After consulting with tourism experts in South Carolina, it was discussed how there is likely an under-estimation of self-employed workers within the tourism and recreation sector of the ocean economy (Jackson, pers. comm., 2020). This evidence is based on the number of Internal Revenue Service 1099-MISC forms submitted by self-employed workers that have maintenance contracts with hotels in South Carolina's beach communities. Since the entities selected for inclusion in the ocean economy are based on North American Industry Classification System codes, it is difficult to determine if certain maintenance companies that are classified under non-ocean economy NAICS codes may also contribute to the ocean economy and/or may obtain part of their revenue from the ocean economy (e.g., a maintenance company classified as a "window cleaning service" that has a maintenance contract with an oceanfront hotel and a non-ocean economy related office building). While there may be some self-employment underestimation in the tourism and recreation ocean economy sector, this is the only consistently produced annual dataset on self-employment in ocean economy sectors, which lends context to trends as well as the relative share of self-employed workers as it compares to the number of employees within ocean economy sectors (e.g., self-employed workers make up a much larger share of employment within the living resources sector).

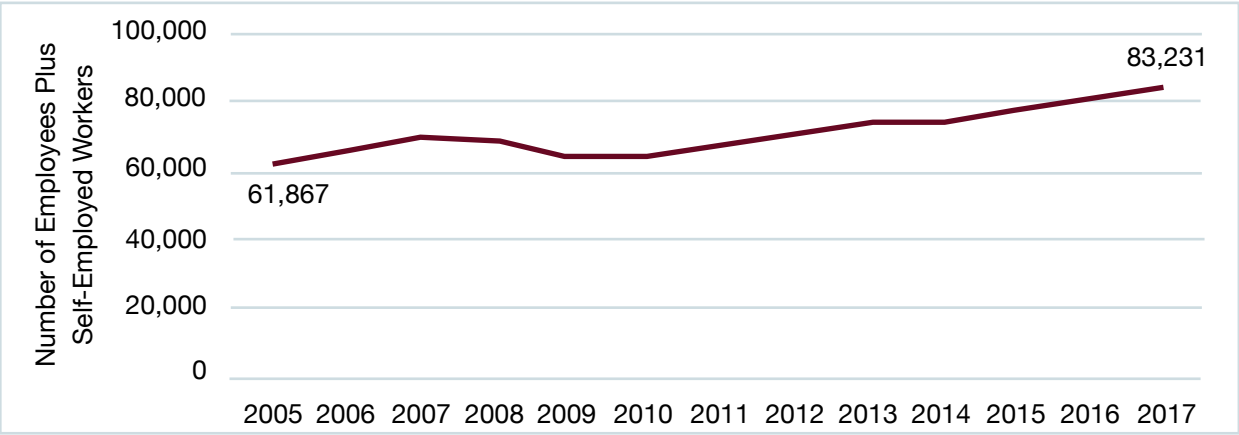


Figure 7: South Carolina Ocean Economy Total Employment Trend, 2005-2017

Table 3 shows how these employment figures relate to the state totals and the coastal county totals in 2017. In 2017, the ocean economy provided employment for 12.2% of coastal county residents and 3.5% of state

residents. The proportion of ocean economy total employment with respect to total statewide employment and total coastal county employment have increased since 2005. The share of ocean economy employment at the statewide level was 3.0% in 2005, and the share of ocean economy employment at the coastal county level was 11.2% in 2005 (NOAA OCM, 2020a; US BEA, 2019a).

Table 3: Relative Size of South Carolina Ocean Economy Employment, 2017

Metric	Ocean Economy	Total Economy for Eight Coastal Counties	Total Economy for South Carolina	Proportion of Coastal County Employment	Proportion of State Employment
Employees	81,632	566,122	2,035,341	14.4%	4.0%
Self-employed workers	1,599	116,550	351,453	1.4%	0.5%
Total employment	83,231	682,672	2,386,794	12.2%	3.5%

Wages and Gross Receipts

In addition to tracking the number of employees and the number of self-employed workers in the ocean economy, ENOW tracks the wages associated with the employees and the gross receipts associated with the businesses started by self-employed workers. Figure 8 shows the trend in inflation-adjusted (real) wages.

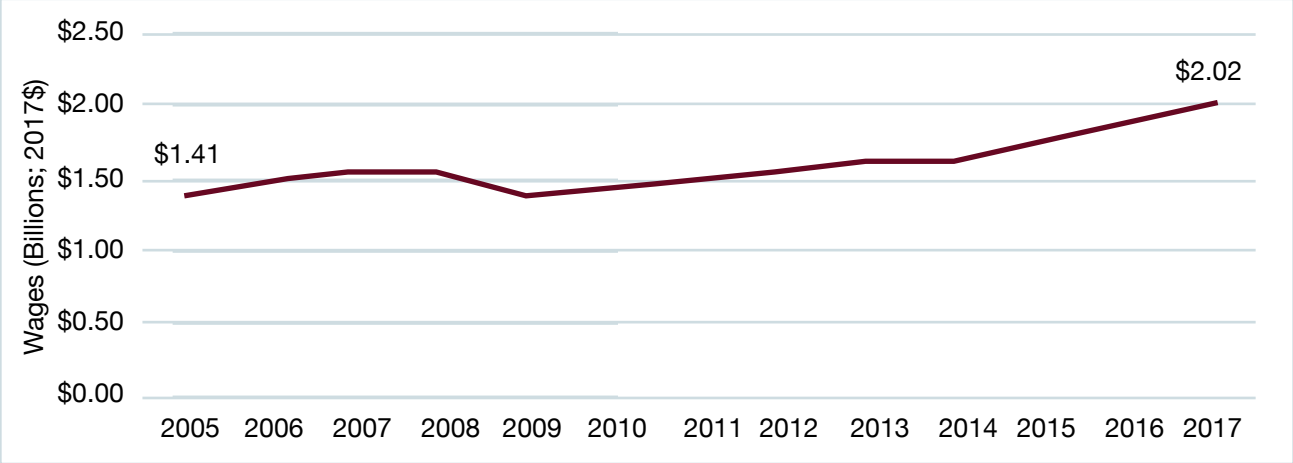


Figure 8: South Carolina Ocean Economy Real Wages, 2005-2017

Since 2005, real wages in the ocean economy sectors have increased by 43%, from $1.41 billion in 2005 to $2.02 billion in 2017.

Self-employed workers' business revenue is tracked by gross receipts (Figure 9). Since 2005, real gross receipts for self-employed workers in the ocean economy sectors have increased by 4%, from $101 million in 2005 to $106 million in 2017.

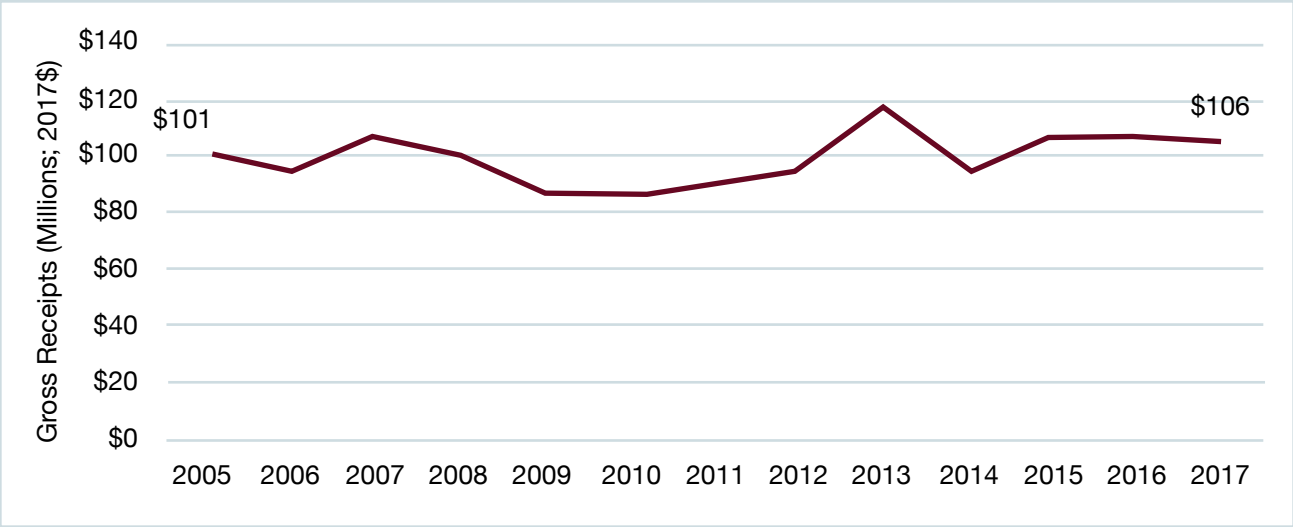


Figure 9: South Carolina Ocean Economy Real Gross Receipts for Self-Employed Workers, 2005-2017

In 2017, wages earned in ocean economy sectors represented 8.4% of all coastal county wages and 2.3% of all state wages; and gross receipts associated with the ocean economy sectors represented 1.9% of all coastal county gross receipts and 0.7% of all state gross receipts.

Gross Domestic Product

Perhaps the most interesting piece of information tracked by ENOW is the contribution the ocean economy provides to overall GDP. Figure 10 shows the trend in real ocean economy GDP. Since 2005, real ocean economy GDP has risen by 57% from $3.04 billion in 2005, to $4.78 billion in 2017.

> The ocean economy has been important to South Carolina in its recovery from the Great Recession, with GDP increasing by 53% in inflation-adjusted value from 2009-2017, compared to 22% for South Carolina's economy as a whole.

In 2017, ocean economy GDP represented 2.1% of total state GDP, and 7.6% of total coastal county GDP. Both of these figures are increases since 2005, when ocean economy GDP was 1.7% of state GDP and 6.4% of coastal county GDP. Not only has the South Carolina ocean economy grown in size, but it has also grown in proportional importance to the entire South Carolina economy. Since the end of the recession (using 2009 as a baseline year), South Carolina's ocean economy GDP in real dollars has grown 53%, compared to just 22% for the state of South Carolina as a whole (NOAA OCM, 2020a; US BEA, 2019b). This suggests that the ocean economy has been of great importance in South Carolina's recovery from the recession.

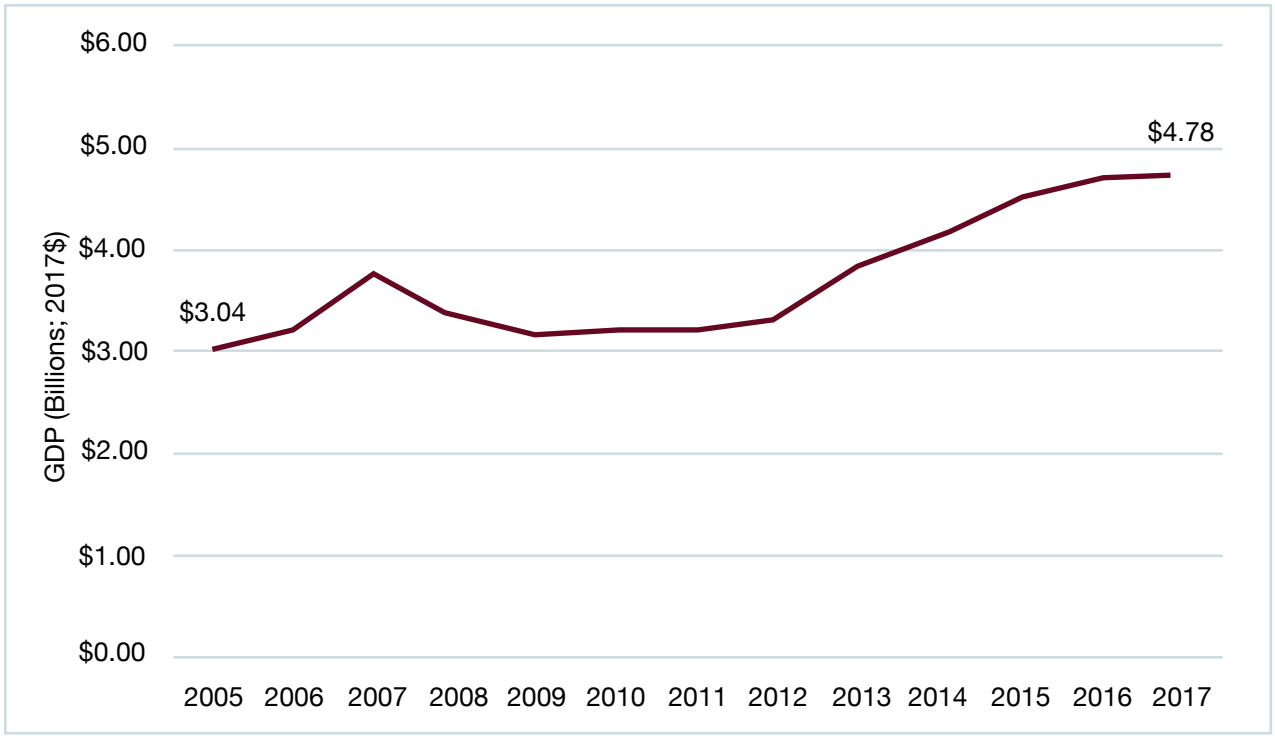


Figure 10: South Carolina Ocean Economy Real GDP Trend, 2005-2017

The ENOW data paint a picture of a growing ocean economy in South Carolina in all metrics tracked by the dataset: establishments, employment, self-employed workers, wages, gross receipts, and GDP. From this point forward, the content of the report will shift to focus on other data sources and studies to provide a more detailed examination of industries dependent upon coastal and ocean environments.

Commercial Fishing and Seafood

Commercial Fishing

Commercial fisheries landings and dockside revenue data in the state are tracked by SCDNR. The data show that over 14.76 million pounds of fish and shellfish were landed for commercial sale in South Carolina in 2019, worth almost $23 million in real dockside revenue (SCDNR, 2020a). In 2019, the top five most landed species by weight were (wild caught) eastern oyster, blue crab, white shrimp, swordfish, and vermilion snapper (Table 4), while the top five most valuable species on aggregate were white shrimp, blue crab, (wild caught) eastern oyster, swordfish, and vermilion snapper (Table 5).

Figure 11 and Figure 12 show the trend in commercial fishery landings and dockside revenue in South Carolina, respectively. Since 2005, the trend in commercial fishery landings has fluctuated, reaching a high of 18.38 million pounds in 2012 (Figure 11). Similarly, the trend in real commercial fishery dockside revenue has fluctuated as well, reaching a high of $26.89 million in 2011. From 2012-2019, commercial fishery landings and real dockside revenue in South Carolina have decreased by 20% and 15%, respectively (Figure 12). The somewhat noticeable drop-off in landings and dockside revenue from 2017 to 2018 can partially be explained by a poor shrimp season caused by the snow and ice event that impacted coastal South Carolina

in January 2018. This led to the fifth worst die-off of shrimp and other species since the 1950s (Petersen, 2019). Landings and real revenue both increased again from 2018-2019.

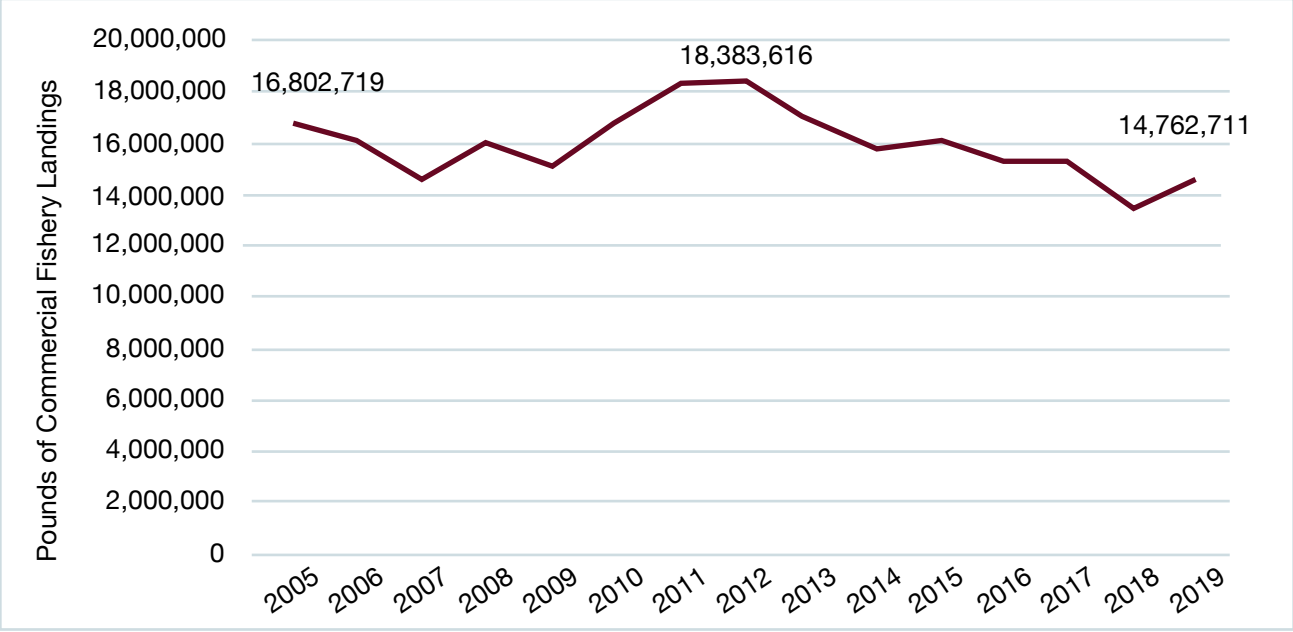
Table 4: Top Five Commercially Landed Finfish and Shellfish Species in South Carolina, 2019

Finfish Species	Landings (lbs)	Shellfish Species	Landings (lbs)[4]
Swordfish	518,947	Oyster, Eastern (Wild)	5,651,683
Snapper, Vermilion	298,710	Crab, Blue	3,971,109
Dolphinfish (Mahi-Mahi)	195,657	Shrimp, White	2,260,121
Sea Bass, Black	86,717	Clams (Wild)	207,877
Grouper, Gag	79,442	Shrimp, Brown	94,410

Table 5: Top Five Most Valuable Commercially Landed Finfish and Shellfish Species in South Carolina, 2019

Finfish Species	Dockside Revenue (2017$)	Shellfish Species	Dockside Revenue (2017$)
Swordfish	$1,594,452	Shrimp, White	$6,750,908
Snapper, Vermilion	$1,091,317	Crab, Blue	$4,912,410
Dolphinfish (Mahi-Mahi)	$551,738	Oyster, Eastern (Wild)	$3,556,986
Grouper, Gag	$451,824	Clams (Wild)	$231,877
Tilefish, Golden	$296,555	Shrimp, Brown	$192,091

Figure 11: Commercial Finfish and Shellfish Landings in South Carolina, 2005-2019



[4] Includes shell weight.

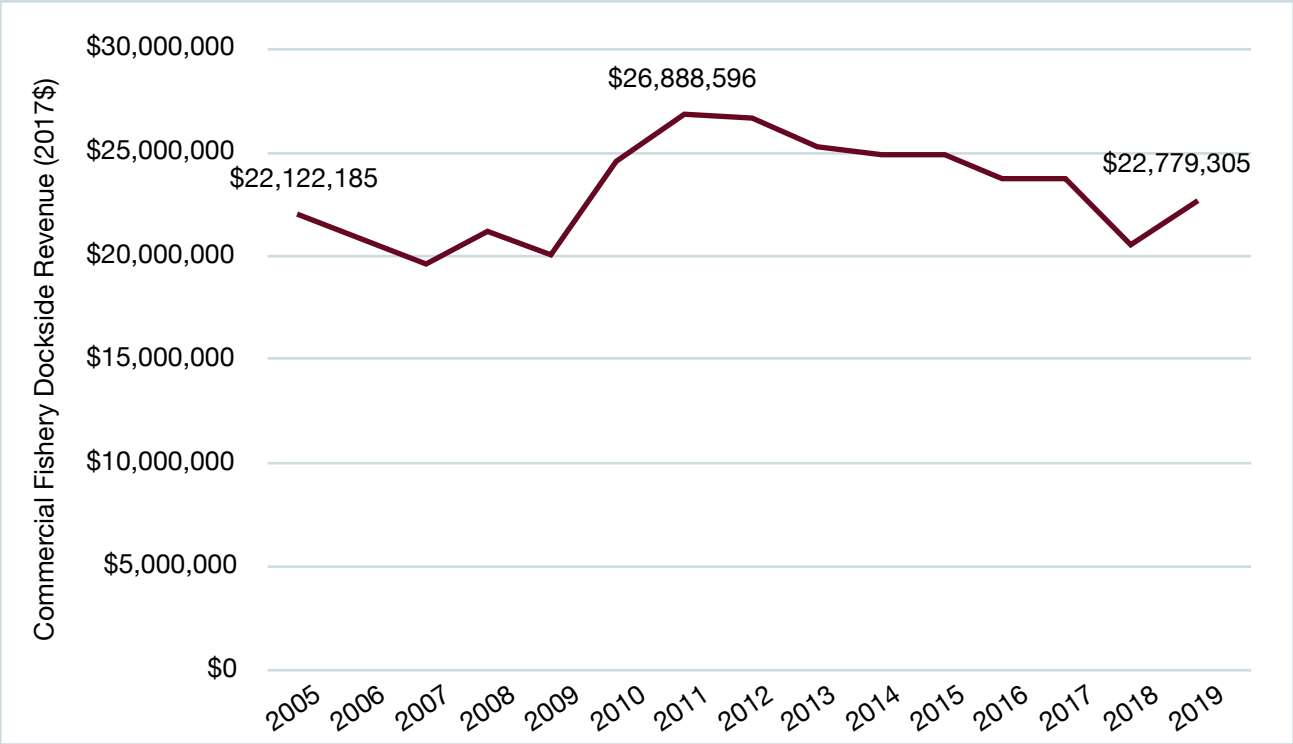


Figure 12: Real Commercial Finfish and Shellfish Dockside Revenue in South Carolina, 2005-2019

Commercial fishing continues to be a rich cultural tradition along South Carolina's coast but has become a riskier occupation in terms of economic returns due to variable year-to-year fluctuations in harvest, increased regulations, overlapping marine uses, competition with seafood imports from foreign countries, and the loss of traditional working waterfronts (Helies et al., 2011).

Figure 13: A Commercial Shrimp Boat Near Beaufort, South Carolina. John Wollwerth / Shutterstock

Seafood Industry

Beyond commercial fishing revenue, NOAA's National Marine Fisheries Service (NMFS) uses an input-output model to estimate the annual economic contribution of the larger seafood industry in South Carolina, defined as "the commercial fishing sector, seafood processors and dealers, seafood wholesalers and distributors, importers, and seafood retailers" (NOAA NMFS, 2011). Input-output models capture how sales in a given economic sector generate economic contributions directly in the sector in which the sale was made, in addition to the sales that then ripple throughout the entire regional economy through other related sectors, allowing researchers to estimate direct, indirect, and induced effects. The total annual economic contribution, including direct, indirect, and induced effects, of the seafood industry in South Carolina in 2017 was $87.64 million in output, $36.00 million in personal income, $47.88 million in contributions to GDP, and 1,454 jobs. When including imports, these figures increase to $159.37 million in output, $50.08 million in personal income, $72.05 million in GDP contributions, and 1,810 jobs (NOAA NMFS, 2020a).

Aquaculture

The commercial aquaculture industry has been growing in South Carolina, with aquaculture farms in the coastal counties typically being mariculture operations, a specific type of aquaculture in which marine organisms are cultivated in sea water (e.g., open ocean, estuaries, bays, creeks), making these types of operations even more dependent upon a healthy coastal and ocean environment.

> The inflation-adjusted dockside value of oyster mariculture production in South Carolina increased by 2,958% from 2012-2019 (SCDNR, 2020b).

As of 2019, 20 oyster mariculture leases are operated in South Carolina, covering 721 acres of water. The dockside value of oyster mariculture has increased substantially in South Carolina since 2012, the first year in which data are available (Figure 14). From 2012-2014, the inflation-adjusted dockside value of oyster mariculture production in South Carolina increased by 251% from $31,157 to $109,258. Growth leveled off from 2014-2016, with dockside value increasing by 27% over this time frame. Exponential growth in dockside value was observed again from 2016-2019, when the inflation-adjusted dockside value of oyster mariculture production in South Carolina increased by 588%, to $952,808, indicating that oyster mariculture is a rapidly expanding ocean economy industry in the state (SCDNR, 2020b).[5]

The stagnation in growth for oyster mariculture production from 2014-2016 can be at least partially explained by a 2014 state moratorium placed on the importation of oyster seed from states north of South Carolina, amid concerns over disease transfer. When the moratorium was instituted, oyster mariculture production in South Carolina was almost exclusively reliant upon out-of-state seed sources. In response to losing vital oyster seed sources, South Carolina oyster growers had to rely on private in-state oyster seed hatcheries

[5] In nominal dollars, the dockside value of oyster mariculture production in South Carolina almost reached $1 million ($999,795) in 2019.

and other out-of-state sources in states south of South Carolina. As the first in-state commercial nursery matured to marketable size and new out-of-state seed sources south of the state were identified, the oyster mariculture industry in the state continued to exhibit high growth rates from 2016-2019. Furthermore, the moratorium on the importation of oyster seed from states north of South Carolina has been lifted as of April 2020 (SCDNR, 2020c).

The 2012-2019 trend for the dockside value of clam mariculture in South Carolina is different, exhibiting more annual fluctuations in value as opposed to the clear upward trend of oyster mariculture. Over this time period, the inflation-adjusted dockside value of clam mariculture peaked in 2016 at $501,532, decreasing by 64% to $180,717 as of 2019 (SCDNR, 2020b). Historically, clam mariculture production far exceeded oyster mariculture production in South Carolina, reaching over $2 million in nominal dockside value in 1999. However, oyster mariculture surpassed clam mariculture in dockside production value for the first time in South Carolina in 2018.

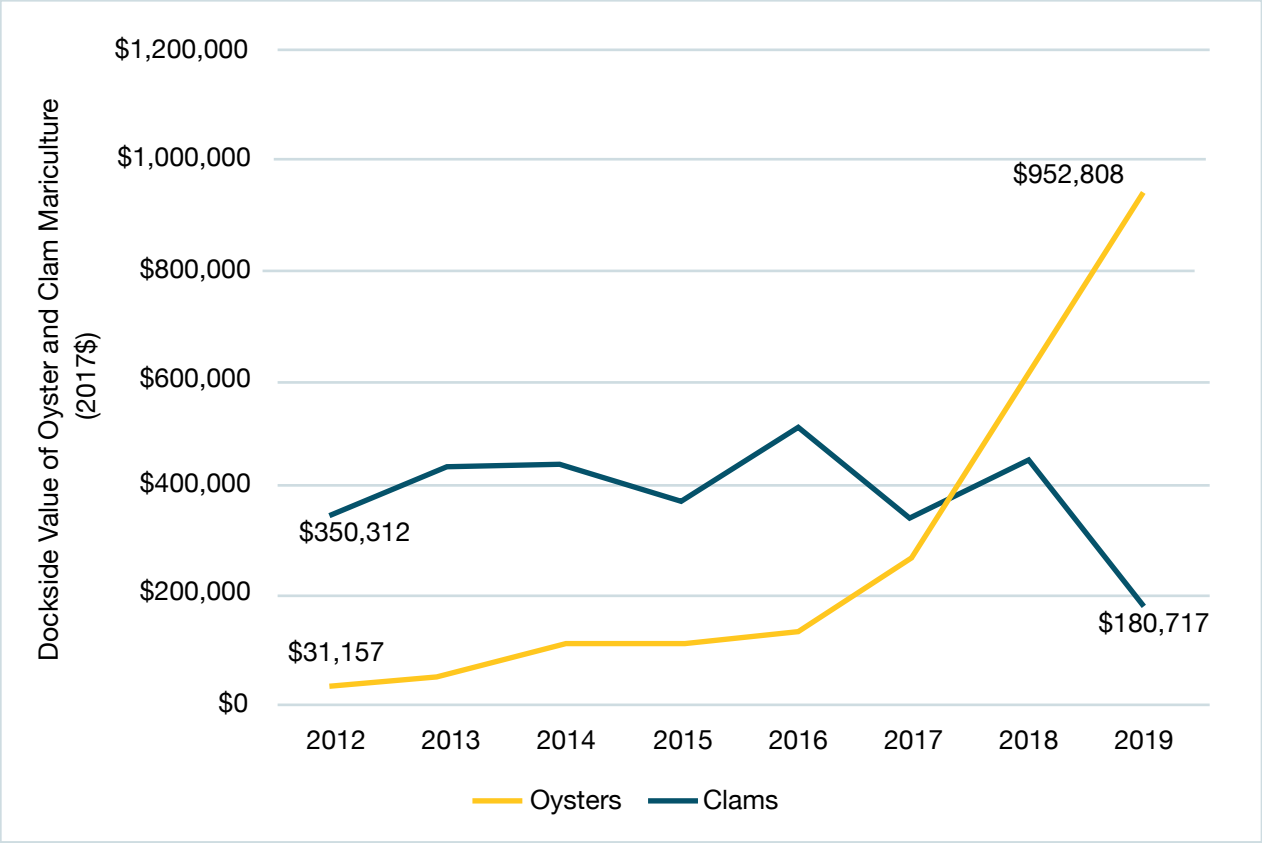


Figure 14: Dockside Value of Oyster and Clam Mariculture Production in South Carolina, 2012-2019

Tourism and Recreation

Visitors travel to South Carolina from both domestic and international origins, and the estimation and summarization of visitors is administered by the South Carolina Department of Parks, Recreation, and Tourism (SCPRT), generally accomplished through marketing research agencies. For 2018, SCPRT derived the state's travel data metrics from OmniTrak's TraveltrakAmerica research panel and estimated that the

2018 annual number of domestic visitors (originating from within state and out-of-state) to South Carolina[6] was approximately 33.8 million people, the annual number of domestic trips was approximately 15.1 million, and the annual number of visitor days was approximately 125.1 million (SCPRT, 2019a). Examining only those who traveled to or within South Carolina for leisure (outdoor recreation, entertainment, sightseeing, other pleasure/personal reasons), the 2018 estimated annual number of domestic visitors to South Carolina[6] was approximately 16.1 million, the annual number of domestic trips was approximately 6.8 million, and the annual number of visitor days was approximately 66.8 million. For out-of-state domestic visitors, 48% of those who traveled for leisure indicated that they went to a beach, compared to 24% for in-state leisure travelers (SCPRT, 2019b; SCPRT, 2019c). The most recent available data on estimated international visitors[7] to South Carolina show an annual visitation level of 614,100 Canadians and 98,969 additional overseas travelers from outside of North America in the year 2015 (SCPRT, 2017).

Domestic visitor expenditures in South Carolina's eight coastal counties for all types of visitors were estimated at $9.13 billion (year 2017 dollars) in 2018, a 2.4% inflation-adjusted increase from 2017 estimates.[8] These expenditures led to associated estimated state and local tax revenues of over $866 million (year 2017 dollars) in 2018, a 1.3% inflation-adjusted increase from 2017 estimates (US Travel Association [USTA][9], 2019). As of 2018, 65% of the entire state's estimated tourism expenditures are generated in the eight coastal counties, and 70% of the state's estimated tourism-related state and local tax revenue is generated in the eight coastal counties (USTA, 2019). Within the coastal counties, beaches in areas like Myrtle Beach and Charleston are popular destinations for in-state and out-of-state visitors. In 2018, Horry, Charleston, and Beaufort were the top three counties in South Carolina in terms of estimated domestic visitor expenditures (Table 6), representing 59% of all estimated domestic visitor expenditures in the state (USTA, 2019). This exemplifies how the coastal counties are of great importance to the state's tourism and recreation economy.

[6] Includes entire state of South Carolina, not limited to coastal counties.

[7] Includes all travelers, not just leisure travelers. Includes entire state of South Carolina, not limited to coastal counties.

[8] All monetary data presented in the tourism/recreation section have been adjusted with the travel price index (USTA, 2020), as opposed to the CPI-U.

[9] The USTA model data does not include "purchases of major consumer durables generally related to outdoor recreation on trips," such as boats (USTA, 2019), which could lead to under-estimation.

Table 6: Estimated Domestic Visitor Expenditures in South Carolina Coastal Counties, 2018

County	Visitor Expenditures (2017 Dollars)	Percent of State Visitor Expenditures	County Rank
Horry	$4,431,742,353	31.5%	1
Charleston	$2,504,643,023	17.8%	2
Beaufort	$1,398,453,075	9.9%	3
Georgetown	$362,449,578	2.6%	8
Berkeley	$147,004,384	1.0%	13
Colleton	$119,405,710	0.8%	15
Dorchester	$100,018,373	0.7%	17
Jasper	$69,133,215	0.5%	19

In addition to commercial fishing, recreational fishing is an important activity in South Carolina, contributing to the lifestyle of South Carolinians as well as the state economy. In 2017, marine recreational anglers took 9,388,908 marine fishing trips in South Carolina, spending $779.93 million. By using an input-output model, NOAA NMFS (2020a) estimated that these expenditures generated a total annual economic contribution (direct, indirect, and induced effects) of 9,803 jobs, $901.60 million in output, $309.57 million in personal income, and $557.26 million in contributions to state GDP. In 2019, it is estimated that the number of marine recreational angler trips in South Carolina increased to 11,838,557, with an associated harvest estimate of 12.4 million pounds of fish and shellfish (NOAA NMFS, 2020b).

As for freshwater recreational fishing (an activity that is not as directly tied to the ocean as marine recreational fishing), the U.S. Fish and Wildlife Service (USFWS) estimated that in 2011,[10] 537,000 freshwater recreational anglers spent 9,221,000 days freshwater fishing, and spent over $517 million (year 2017 dollars) in total trip-related and equipment expenses (USFWS, 2014).

From July 2017 to June 2018, 218,429 people (including residents and non-residents) purchased saltwater fishing licenses, generating $2,618,688 (year 2017 dollars) in revenue for the state (SCDNR, 2018).

While estimates regarding the economic contributions of marine recreational fishing and recreational boating overlap, the National Marine Manufacturers Association (NMMA) tracks annual economic trends in the recreational boating industry. The latest figures indicate that there are 551,477 registered recreational boats in South Carolina, and the recreational boating industry produces an annual economic contribution (including direct, indirect, and induced effects) of $3.80 billion in output[11] (year 2017 dollars) and supports 15,064 jobs in South Carolina (NMMA, 2018). It should be noted that these recreational boating figures are not confined to ocean and estuarine environments and therefore include figures related to recreational boating in other inland waterbodies as well.

[10] After 2011, the USFWS discontinued its state-level wildlife-related recreation surveys. Consequently, the participation values reported for freshwater recreational fishing are most likely out of date relative to 2020.

[11] Includes manufacturers and suppliers, sales and services, boating activities, and business tax revenue.

Willis and Straka (2017) used an input-output model to estimate the total economic contribution of tourism in South Carolina's coastal counties, including direct, indirect, and induced effects. They found that tourism expenditures in the coastal counties in the year 2012 led to an estimated total economic contribution of $9.20 billion in output, $2.94 billion in income, $4.97 billion in contributions to GDP, and 99,325 jobs (year 2017 dollars).

Port Operations

The U.S. Census Bureau U.S.A. Trade Online database tracks imports and exports at the port level from five identified ports in South Carolina: The Port of Charleston, Port of Columbia, Port of Georgetown, Port of Greenville-Spartanburg (Inland Port in Greer), and the Port at Myrtle Beach International Airport. In 2019, these ports exported $38.68 billion worth of goods and imported $51.58 billion worth of goods (year 2017 dollars, Table 7). It is also important to note that not all imports coming through South Carolina's ports are destined for South Carolina businesses, and not all exports sent out through South Carolina ports originate from South Carolina businesses. According to data from Wilbur Smith Associates and the U.S. Foreign Trade Division, approximately 74% of the total cargo exported through South Carolina port facilities originates from businesses located in South Carolina, and approximately 26% of the total cargo imported through South Carolina port facilities is destined for businesses in South Carolina (Wilbur Smith Associates Inc., 2008). Additional figures are provided in Table 7 to take these factors into account, multiplying export cargo values by 74%, and multiplying import cargo values by 26%.

In terms of trends, both the inflation-adjusted market value of imports and exports have increased since the end of the recession in 2009, although the inflation-adjusted market value of imports peaked in 2015 (Figure 15). From 2009-2019, the inflation-adjusted market values of imports and exports have increased by 56% and 107%, respectively. Also during this period, the export market value to import market value ratio has increased from 0.57 to 0.75, indicating that although South Carolina imports more cargo value than it exports, the state has increased its share of export cargo value, relative to import cargo value (US Census Bureau, 2019c).

Table 7: Market Value of Imports and Exports at South Carolina's Ports, 2019

South Carolina Port	Total Export Cargo Value (2017 Dollars)	Total Import Cargo Value (2017 Dollars)	Export Cargo Value from S.C. Businesses (2017 Dollars)	Import Cargo Value for S.C. Businesses (2017 Dollars)
Port of Charleston	$38,450,496,332	$48,470,623,475	$28,453,367,286	$12,602,362,103
Port of Columbia	$1,450,546	$1,504,477	$1,073,404	$391,164
Port of Georgetown	$4,451,198	$7,798,218	$3,293,886	$2,027,537
Inland Port in Greer	$217,392,479	$3,097,509,376	$160,870,434	$805,352,438
Port at Myrtle Beach International Airport	$3,783,883	$0	$2,800,073	$0
Total	**$38,677,574,438**	**$51,577,435,546**	**$28,621,405,084**	**$13,410,133,242**

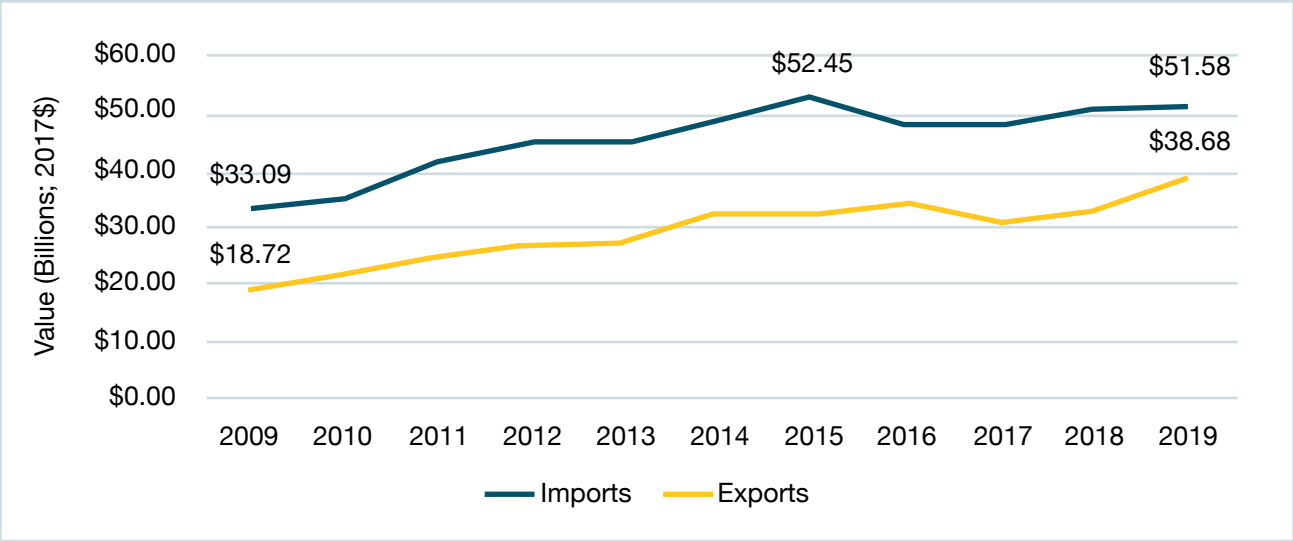


Figure 15: Market Value of Imports and Exports at South Carolina's Ports, 2009-2019

In addition to the data in Table 7, the estimated annual economic contributions (direct, indirect, and induced effects) of South Carolina's ports that are administered by the South Carolina Ports Authority (SCPA)[12] were estimated in 2018 using an input-output model (Von Nessen, 2019). The analysis was divided into an assessment of port operations (SCPA cargo handling services, freight transportation arrangement, marine cargo handling, and select trucking services) and port users (the business activity that is made possible by the presence of SCPA ports that would not otherwise exist). The estimated total annual economic contribution of SCPA ports is shown in Table 8.

Table 8: Estimated Annual Economic Contribution of SCPA Ports, 2018

	Port Operations	Port Users
Personal Income (2017 Dollars)	$984,022,160	$11,485,527,255
Output (2017 Dollars)	$3,072,022,427	$58,800,227,833
Employment	19,621	205,342

Non-Market Ecosystem Services

The ecosystem services provided by South Carolina's coastal and ocean natural resources are necessary for a thriving ocean economy, and healthier natural resources produce more ecosystem services. Ecosystem services are typically grouped into four categories: supporting (e.g., soil formation, nutrient cycling), provisioning (e.g., food, water, timber), regulating (e.g., shoreline stabilization, water purification), and cultural (e.g., aesthetic, spiritual, recreational) services (Millennium Ecosystem Assessment, 2005). As previously mentioned, not all economic benefits of the ocean economy are captured with market data. There are other

[12] The SCPA administered three ports at the time of the study: The Port of Charleston, Port of Georgetown, and the Inland Port in Greer.

non-market economic benefits that a healthy coastal and ocean environment with its associated habitats provide, such as shoreline protection, carbon storage, water quality, and biodiversity. These ecosystem services benefit humans in a variety of ways, including the provision of clean air, clean water, recreational opportunities, safety, and increased property values. Without comparable market price data, these non-market ecosystem service values must be estimated with non-market valuation techniques, which can include estimating people's willingness to pay for sea turtle preservation through surveys, estimating property damages with and without the presence of coastal habitats to estimate shoreline protection benefits, and estimating prices for property attributes to understand how beaches influence adjacent property values, among others.

Ecosystem Functions refer to the habitat, biological, or system properties or processes of ecosystems. ***Ecosystem Services*** represent the benefits human populations derive, directly or indirectly, from ecosystem functions (Costanza et al., 1997).

South Carolina's coastal ecosystems are home to a wide variety of diverse plants and animals, including fish and shellfish that are staples of the human diet. The coastal ecosystems also provide critical shorebird and sea turtle habitat, and are home to marine mammals like bottlenose dolphins. Studies have shown that humans value the existence of biodiversity and rare or endangered species, and are willing to pay to preserve it (Martin-Lopez et al., 2008; Richardson and Loomis, 2009). Selected habitats found in coastal South Carolina and their associated ecosystem service benefits based on previous studies and existing information are discussed below. There is certainly potential for expanding these types of assessments and analyses in the future as researchers begin to understand more about socioecological systems and the relationships within them.

Wetlands

Wetlands (e.g., freshwater, brackish, and salt marshes) provide a variety of ecosystem services to humans including natural hazard regulation (e.g., buffers against wave energy, erosion mitigation, floodwater storage), habitat for commercially important fish and shellfish species, water quality improvements, recreational opportunities (e.g., fishing and boating), carbon storage, and aesthetically pleasing views (Mitsch et al., 2015).

Sun and Carson (2020) analyzed reported property damages from every tropical storm and hurricane that hit the U.S. from 1996-2016 to estimate the expected annual economic value of the protective effects of coastal wetlands for each county along the U.S. Atlantic and Gulf coasts. The analysis involved an investigation into each county's area of coastal wetlands and the habitat's influence on reported countywide tropical cyclone damages, while controlling for the probability of a given county being impacted by a tropical cyclone, which side of the center of the storm path the county was on, storm wind speed, geographic extent of storm area, and county housing values. The study found that the estimated annual protective value of coastal wetlands in South Carolina can range from $1,500 - $17,000 per hectare (ha) per year depending on the county

(Table 9). Based on an area of 672,035 ha of wetlands (estuarine and marine wetlands, freshwater emergent wetlands, and freshwater forested/shrub wetlands) in South Carolina's coastal counties according to the National Wetlands Inventory (USFWS, 2018a), wetlands in South Carolina's coastal counties are estimated to provide over $3.9 billion per year in shoreline protection benefits.

Table 9: Estimated Annual Coastal Protection Value of Wetlands in South Carolina's Coastal Counties

County	Area of Wetlands (ha)	Value per ha (2017 Dollars)	Total Protection Value (2017 Dollars)
Beaufort	72,583	$5,107	$370,645,250
Berkeley	92,183	$6,230	$574,295,995
Charleston	108,899	$3,677	$400,389,956
Colleton	96,804	$1,940	$187,845,614
Dorchester	44,988	$17,362	$781,095,195
Georgetown	83,810	$3,472	$291,023,892
Horry	102,394	$11,847	$1,213,068,224
Jasper	70,374	$1,532	$107,810,230
TOTAL	**672,035**	**—**	**$3,926,174,355**

Wetlands trap sediment that flows downstream from rivers in the upstate, improving nearby and adjacent water quality. By removing sediment, wetlands prevent water from getting cloudy, which could disrupt food chains by inhibiting plant growth and the production of microorganisms. In addition, sediment removal saves municipalities money on water treatment costs. Wetlands also act like sponges, absorbing and holding water, and releasing it slowly. Water gathers in wetlands from rain and river discharges, and flows gradually into nearby streams and creeks. The water held back by wetlands helps recharge groundwater sources, helping to maintain our water supplies by increasing the amount of water remaining in aquifers. The values for water quality protection and water supply protection ecosystem services provided by South Carolina's wetlands were estimated by Adusumilli (2015) using a value-function transfer approach based on a meta-analysis of wetland valuation literature, controlling for the distribution of wetlands and socioeconomic characteristics within a given state. This study found that the estimated economic benefits of water quality protection services provided by wetlands in South Carolina can range from $892 to $1,114 per ha per year, with an average of $1,003 per ha per year in year 2017 dollars. Based on an area of 672,035 ha of wetlands in South Carolina's coastal counties (USFWS, 2018a), wetlands in South Carolina's coastal counties are estimated to provide $673.9 million per year in water quality protection benefits, on average. Adusumilli (2015) also found that the estimated economic benefits of water supply protection services provided by wetlands in South Carolina can range from $56 to $71 per ha per year, with an average of $64 per ha per year in year 2017 dollars. Based on an area of 672,035 ha of wetlands in South Carolina's coastal counties (USFWS, 2018a), wetlands in South Carolina's coastal counties are estimated to provide over $42.9 million per year in water supply protection benefits, on average.

Wetlands also prevent carbon from being released into the atmosphere through a process known as carbon

sequestration, which has implications for climate change mitigation. Drexler et al. (2013) found the average carbon sequestration rates for freshwater wetlands in an estuary along the Lower Waccamaw River in South Carolina to be 50-200 grams per square meter per year for freshwater wetlands with moist soils, and 100-435 grams per square meter per year for naturally tidal freshwater wetlands. Currently, there are no published estimates for carbon sequestration rates of salt marshes in South Carolina, however Loomis and Craft (2010) found that brackish marshes in Georgia sequester carbon at a rate of 93 grams per square meter per year, and that salt marshes in Georgia sequester carbon at a rate of 40 grams per square meter per year.

In the year 2020, the U.S. Environmental Protection Agency (EPA) projects the social cost of carbon to be $49.66 per metric ton per year (year 2017 dollars, Interagency Working Group on Social Cost of Greenhouse Gases, 2016).

In order to get a rough estimate of the economic benefits of carbon sequestration provided by South Carolina's wetlands, the midpoint of the "moist soil" carbon sequestration rate range provided by Drexel et al. (2013) is applied to the area of freshwater forested/shrub wetlands in the coastal counties, the midpoint of the "tidal" carbon sequestration rate range provided by Drexel et al. (2013) is applied to the area of freshwater emergent wetlands in the coastal counties, and the average of the brackish and salt marsh carbon sequestration rate estimates provided by Loomis and Craft (2010) is applied to the area of estuarine and marine wetlands in the coastal counties. Each of these rates are then converted to metric tons per ha per year, and multiplied by the social cost of carbon to estimate the economic benefits of carbon sequestration provided by South Carolina's wetlands at over $41 million per year (Table 10).

Table 10: Estimated Economic Benefits of Carbon Sequestration in South Carolina's Coastal Counties

Wetland Type	Area (ha)	Carbon Sequestration Rate (MT/ha/yr)	Social Cost of Carbon (2017$/ MT/yr)	Economic Benefits per Year (2017 Dollars)	Benefits per ha per Year (2017 Dollars)
Estuarine and Marine Wetland	159,885	0.665	$49.66	$5,280,279	$33
Freshwater Emergent Wetland	55,597	2.675		$7,385,895	$133
Freshwater Forested/Shrub Wetland	456,554	1.250		$28,342,005	$62
TOTAL	**672,035**			**$41,008,180**	

Beaches

Sandy beaches provide a host of ecosystem services to humans as well. These include natural hazard regulation (e.g., buffers against wave energy, erosion mitigation, dynamic response to sea level rise), recreational opportunities (e.g., fishing, beach recreation), sediment storage and transport, nesting habitat for shorebirds and sea turtles, and aesthetically pleasing views (Defeo et al., 2009).

South Carolina beaches provide critical nesting habitat for sea turtles (mostly loggerhead sea turtles, with some rare sightings of green turtles and Kemp's ridley turtles), animals commonly identified with other

charismatic megafauna as having societal value. In South Carolina, sea turtles are a popular species and symbol along the coast, found in works of art and serving as fundraiser causes. The South Carolina Aquarium partners with SCDNR to run the Sea Turtle Care Center, aiding in the conservation of sea turtle species. Rehabilitated sea turtles are also returned to the wild when appropriate, and the South Carolina Aquarium and SCDNR organize sea turtle release events for the public to attend. All of these activities provide evidence that these species are valued by coastal communities in the state.

People's values for the existence of rare and endangered species are commonly estimated through the contingent valuation method. A study in North Carolina found that the recreational non-consumptive use value of loggerhead sea turtle nesting habitat was $22.81 per household per year in year 2017 dollars[13] (Whitehead, 1992; Rhodes and Pan, 2015). This study used the contingent valuation method to estimate peoples' stated willingness to pay for the preservation of loggerhead sea turtle habitat. Adjusting for geography based on median household income in North Carolina ($26,647) and South Carolina ($26,256) at the time of Whitehead's report (1992)[14], South Carolina households are estimated to be willing to pay $22.48 per household per year for the preservation of loggerhead sea turtle habitat.

Placing a monetary value on rare or endangered species such as sea turtles can also be estimated through the civil fines levied against those who disrupt the protection of these species, with the understanding that the presence of the species is assumed to be worth at least as much as the fine incurred for taking it. This method has been used in past studies for valuing an array of rare species, endangered species, and game species (Bodenchuk et al., 2002; Engeman et al., 2002, 2004, 2016, 2019; Shwiff et al., 2007). Particularly, Engeman et al. (2019) used this method to estimate the economic consequences of turtle nest predation carried out by feral hogs from 2010-2017 on North Island in South Carolina. Rare and endangered species are almost universally protected with penalties established in legislation, and the South Carolina statutes (§ 50-15-30; § 50-15-80) that address fines for the unlawful take of such species specifies that violators must be fined $1,000 for such offenses. Instead of applying this fine on a per-hatchling basis as Engeman et al. (2019) did in their valuation for North Island in South Carolina, this report will use a more conservative approach of applying this $1,000 value to the number of sea turtle nests identified on South Carolina beaches. The SCDNR Marine Turtle Conservation Program identified 8,802 sea turtle nests in 2019, a record year since monitoring started in the 1980s (SCDNR, 2020d). Based on this estimate of $1,000/nest, the presence of sea turtle habitat was estimated to be worth $8,802,000 in South Carolina in 2019.

Beaches in South Carolina have also been empirically shown to increase the value of adjacent and nearby properties. As Pompe and Rinehart (1999) state, this is due to a combination of amenity value, erosion control, and flood protection services provided by beaches. Catma (2020) conducted a hedonic analysis to estimate beach width's influence on property values on Hilton Head Island in South Carolina, while controlling for other property characteristics like building square footage, lot area, number of bedrooms, number of bathrooms, age of home, garage presence, number of stories, distance to beach, if the property was on the oceanfront, distance to nearest beach access, owner residency, and whether the house was in a gated community. Catma (2020) found that beaches are estimated to increase the value of oceanfront

[13] Value adjusted using the CPI-U based on 2014 value of $22.03 reported in Rhodes and Pan (2015).

[14] Derived median household income figures from 1990 U.S. Decennial Census.

residential property by $3,076 per foot of beach width per property (year 2017 dollars). When examining the overall price premium paid by oceanfront residential property owners on Hilton Head Island, Catma (2020) estimated that there was a 61.9% price premium for residential properties on oceanfront lots. Based on the average oceanfront property price in year 2017 dollars ($3,042,649) in the dataset used by Catma (2020), this equates to average price premium attributable to living on the oceanfront of $1.88 million per oceanfront property. Multiplied by the number of oceanfront lots (86) in the dataset used by Catma (2020), it is estimated that the presence of the oceanfront adds a total of over $161.97 million to oceanfront properties on Hilton Head Island. Due to varying beach widths, erosion rates, and property values across barrier islands in South Carolina, these estimates should be used only for Hilton Head Island.

Beach renourishment is a common strategy that coastal communities utilize to combat beach erosion, restoring and preserving the ecosystem services associated with wider beaches. Blackwell et al. (2010) used repeat property sales data and beach renourishment project costs from 1986-2005 to compare property value appreciation rates in a beach community with multiple renourishment projects over the identified time period (Folly Beach) with rates in a beach community without any renourishment projects (Isle of Palms). This study found that beach renourishment has helped maintain property value appreciation rates on Folly Beach.

Sand Dunes

Beaches with vegetated sand dunes provide additional ecosystem services. Sand dunes regulate natural hazards (e.g., buffers against wave energy, erosion mitigation, dynamic response to sea level rise), provide nesting habitat for shorebirds and sea turtles, improve air quality due to vegetation, form soil, and provide aesthetically pleasing views (Everard et al., 2010). The natural hazard regulation services provided by beaches with vegetated sand dune features are more pronounced than those provided by sandy beaches without dunes due to the height of the dune and the increased friction associated with vegetation.

Braud (2018) utilized flood modeling scenarios with and without the presence of sand dunes and found that the presence of sand dunes in Isle of Palms, S.C. help the community avoid an estimated $14,919 in damages during a 100-year storm event[15] while taking first floor elevation of raised structures into account ($14,563 in year 2017 dollars). Based on an area of 50 ha of sand dunes on Isle of Palms (Braud, 2018), this equates to an estimated protection value of $291/ha for sand dunes on the island during a 100-year storm event. If all structures were at ground elevation level, the estimated community-level avoided damages due to sand dune presence on Isle of Palms during a 100-year storm event increase to over $4.25 million ($4.15 million in year 2017 dollars; $83,057/ha), suggesting that sand dunes play an important role in reducing storm surge and inundation levels for nearby and adjacent properties. It should be noted that the sand dune system and development characteristics on Isle of Palms are unique, so the estimates in this section should not be transferred to other sand dune systems on different barrier islands.

Oyster Reefs

Oyster reefs, a staple along the South Carolina coast and a habitat closely tied to the region's sociocultural history, are significant providers of ecosystem service benefits, including water quality improvements,

[15] A 100-year storm event has a 1% chance of occurring in any given year.

primary production of commercially important fish and shellfish species, habitat for commercially important fish and shellfish species and many other marine species, natural hazard regulation (e.g., buffers against wave energy, erosion mitigation), recreational opportunities, and food for residents and visitors (Grabowski et al., 2012; Coen et al., 2007; Michaelis, 2018).

Grabowski et al. (2012)[16] found that the non-harvest value of oyster reefs, including ecosystem services such as fisheries production, nitrogen removal (improving water quality), and shoreline protection, can range from $6,002 to $105,525 per ha per year, with an average of $9,843 per ha per year in year 2017 dollars. Based on an area of 2,024 ha of live oyster reefs in South Carolina's coastal counties (SCDNR, 2015), oyster reefs in South Carolina's coastal counties are estimated to provide over $19.9 million per year in ecosystem service benefits, on average. It should be noted that Grabowski et al. (2012) focused on habitats mostly in North Carolina and Virginia, so these monetary figures should be treated with caution when interpreting them for South Carolina.

Figure 16: An Oyster Bed, Morris Island, South Carolina. Kim McGrew / Shutterstock

[16] The authors also valued the enhancement services that oyster reefs provide to submerged aquatic vegetation, but this value was not included in this report as there is no submerged aquatic vegetation in South Carolina (Atlantic States Marine Fisheries Commission, 2018).

A SUMMARY OF SOUTH CAROLINA'S OCEAN ECONOMY

To put South Carolina's ocean economy in perspective, a framework is adapted from Harrison (2017). Table 11 details the economic benefits provided by South Carolina's ocean economy.

When interpreting the data provided in Table 11, it is important to note that while the data in the "sourced from NOAA OCM (2020a)" column can be aggregated with each other, the additional values, impacts, and contributions provided in the "sourced from other studies" column are, in most cases, not mutually exclusive from the NOAA OCM ocean economy data, nor are they mutually exclusive from one another, and may have also been derived through different methods at different points in time. Therefore, it is important to note that these additional contextual values provided should not be aggregated into the data provided by NOAA OCM, nor should they be aggregated with one another. For example, there is potential double counting if one were to aggregate the economic contribution of marine recreational fishing with the economic contribution of ship and boat building as these estimates overlap when marine recreational anglers pay to repair their boats. There is also potential double counting if one were to aggregate the economic contribution of marine recreational fishing, the economic contribution of recreational boating, and the economic contribution of coastal tourism, as these three populations of people overlap. Relatedly, it is also noted that in some cases, market and non-market benefits should not be aggregated. For example, Grabowski et al.'s (2012) estimate for the non-market ecosystem service value of oyster reefs includes an estimate for oysters' contribution to commercial fisheries production. Therefore, this should not be aggregated with the market-based estimate for the economic contribution of commercial fishing.

THE FUTURE OF SOUTH CAROLINA'S OCEAN ECONOMY

Four ocean economy sub-sectors are identified below and areas of potential growth for South Carolina: oyster mariculture, renewable energy, nature-based tourism and ecotourism, and marine biotechnology.

Oyster Mariculture

Oyster mariculture is one industry already growing rapidly. South Carolina's tidal creeks and estuaries are suitable environments for oysters to thrive, with inflation adjusted wild caught Eastern Oyster dockside revenue reaching over $3.5 million in South Carolina in 2019 (SCDNR, 2020a). Given that South Carolina's coastal ecosystems support wild oyster production, there is opportunity for culturing oysters as well. Oyster mariculture is a growing industry in South Carolina (Figure 14), increasing by 2,958% in inflation-adjusted dockside value from 2012-2019 (SCDNR, 2020b). The inflation-adjusted dockside value (year 2017 dollars) of oyster mariculture in South Carolina has grown from just over $31,000 in 2012 to just under $953,000 in 2019.

Wild oysters in South Carolina grow in clusters due to the intertidal nature of the environment, but culturing oysters allows for single oyster production in the state, and advancements in cage technology have led to the minimization of air exposure which allows oysters to be safely cultured and consumed year-round.

Growing single oysters offers farmers more economic opportunity, as these types of oysters are most preferred by high-end restaurants with raw bars and thus command a higher price premium. While the dockside value of oyster mariculture production increased exponentially from 2016-2019 (Figure 14) even after the 2014 moratorium on importation of oyster seed from north of South Carolina, oyster mariculture in South Carolina remained largely dependent on out-of-state seed sources in states south of South Carolina, with a smaller amount of seed produced in-state at two private hatcheries. Until the moratorium was lifted in April 2020, a primary concern of industry members was identifying a long-term, sustainable source of seed so that the industry can meet the demand of their customers and continue to grow. With more options for oyster seed now legally available to growers in South Carolina, it is anticipated that this will have a positive effect on the local industry.

It also must be noted that there is a challenge related to the social carrying capacity of the oyster mariculture industry in South Carolina. With expansion, there will necessarily be spatial overlapping with other uses of waterways, such as recreational boating, fishing, and scenic views. Identifying waterways suitable for oyster mariculture that minimize overlap with other competing human uses will be key as the industry expands.

Moreover, it has been found that South Carolinians are willing to pay a price premium for shrimp products cultured in South Carolina (Soley et al., 2019). It can be reasonably assumed that this preference extends to oysters cultured in the state as well. Given the state's expansive system of tidal creeks and estuaries, South Carolina has an opportunity to be a regional leader in oyster mariculture. Furthermore, given the valuable ecosystem service benefits that oysters provide beyond what is captured in markets (Grabowski et al., 2012; Gentry et al., 2020), oyster farms enable the production of various co-benefits, such as water quality improvements, turbidity reduction, wave energy attenuation, wetland habitat improvements, and cultural value, all of which benefit society.

Renewable Energy

South Carolina has the sixth-highest offshore wind energy potential in the U.S. according to Musial et al. (2016). If this potential is achievable, offshore wind power could exceed the state's current electricity use (American Jobs Project, 2018). Demand for offshore wind energy continues to rise, and costs of production continue to fall with advances in technology and economies of scale. The levelized cost of energy[17] of offshore wind fell almost 18% from 2010-2016, and the global offshore wind industry is predicted to grow at an annual rate of 16% between 2017 and 2030 (American Jobs Project, 2018).

South Carolina has four Wind Energy Areas (Figure 17) in the Bureau of Ocean Energy Management's (BOEM) lease process (BOEM, 2015). Approximately 48 companies and facilities in South Carolina currently are involved in the full value chain of the wind energy industry (Oteri et al., 2018). If the state's resources were mobilized to realize South Carolina's offshore wind energy potential with a realistic "low deployment

[17] The levelized cost of energy measures lifetime costs divided by energy production. It involves the calculation of the present value of the total cost of building and operating some form of energy production infrastructure over an assumed lifetime, and allows the comparison of different technologies.

Table 11: South Carolina's Ocean Economy Snapshot, Year 2017 Dollars

Ocean Sector	Sub-Sectors	Sourced from NOAA OCM (2020a)					Sourced from Other Studies
		GDP ($ millions)	Employment		Income ($ millions)		Economic Values, Impacts, and Contributions[A]
			Emp	Self-Emp	Wages	GR	
Living Resources	Fisheries • Finfish Fishing • Shellfish Fishing • Other Marine Fishing	$41.32	539	530	$17.25	$27.78	Economic contribution without imports (NOAA NMFS, 2020a): • $42.22 million output • $16.72 million income • $22.98 million GDP
	Processing, Retailing • Preparation and Packaging • Canning • Seafood Processing • Seafood Wholesalers, Distributors						Economic contribution without imports (NOAA NMFS, 2020a): • $45.42 million output • $19.28 million income • $24.90 million GDP
	Aquaculture • Finfish Farming • Shellfish Farming • Other Aquaculture						Dockside value of mariculture (SCDNR, 2020b): • $952,808 oysters • $180,717 clams
Marine Transportation	Transport • Deep-sea and coastal freight transportation • Deep-sea and coastal passenger transportation • Port and harbor operations • Marine-cargo warehousing • Search and navigation • Other support activities	$501.84	5,283	382	$264.51	$20.29	Economic contribution of SCPA port operations (Von Nessen, 2019): • $3.07 billion output • $984.02 million income Economic contribution of SCPA port users (Von Nessen, 2019): • $58.80 billion output • $11.49 billion income
Marine Construction	Marine-related construction	$108.12	775	61	$50.74	$5.65	Not Available
Offshore Mineral Extraction	Minerals: Metals, limestone, sand, and gravel • Sand and gravel mining • Stone mining and quarrying • Metal mining • Other mineral mining	$24.00	197	23	$9.69	$1.90	Mineral Mining[B] industry output; Direct economic contribution (Willis and Straka, 2016): • $431.51 million
	Energy: Oil and gas • Crude petroleum and natural gas extraction • Drilling oil and gas wells • Support activities • Renewables						Energy Mining[C] industry output; Direct economic contribution (Willis and Straka, 2016): • $414.56 million
	Marine biotechnology • Pharmaceuticals, chemicals						Not Available
Tourism and Recreation	Tourism • Eating and drinking places • Hotels and lodging • Marinas • RV parks and campsites • Scenic water tours • Sporting goods (purchases, rentals, instruction • Amusement/recreation services • Nature parks, zoos, and aquaria	$3,856.09	71,840	582	$1,541.00	$47.22	Economic contribution of coastal tourism (Willis and Straka, 2017): • $9.20 billion output • $2.94 billion income • $4.97 billion GDP

Ocean Sector	Sub-Sectors	Sourced from NOAA OCM (2020a)					Sourced from Other Studies
		GDP ($ millions)	Employment		Income ($ millions)		Economic Values, Impacts, and Contributions[A]
			Emp	Self-Emp	Wages	GR	
Tourism and Recreation	Marine recreational fishing	$3,856.09	71,840	582	$1,541.00	$47.22	Economic contribution of marine recreational fishing (NOAA NMFS, 2020a): • $901.60 million output • $309.57 million income • $557.26 million GDP
	Recreational boating						Economic contribution of recreational boating (NMMA, 2018): • $3.80 billion output
Ship and Boat Building	Ship and boat building • Ship building and repair • Boat building and repair	$244.47	2,998	21	$139.97	$2.79	Economic contribution of shipbuilding and repairing industry (MARAD, 2015): • $206.23 million income • $312.51 million GDP
Non-Market Ecosystem Services							
Wetlands	Shoreline protection, carbon sequestration	Not available					Coastal protection (Sun and Carson, 2020): • $1,532 - $17,362 per ha per year depending on county Carbon sequestration (Drexel et al., 2013; Loomis and Craft, 2010): • $33-133 per ha per year depending on wetland type Water quality protection (Adusumilli, 2015)[D]: • $1,003 per ha per year Water supply protection (Adusumilli, 2015)[D]: • $64 per ha per year
Beaches	Enhancement of property values through flood protection, erosion control, amenity value; and wildlife habitat	Not available					Market value of a foot of beach width on oceanfront lots on Hilton Head Island, S.C. (Catma, 2020): • $3,076 per oceanfront property Willingness to pay for loggerhead sea turtle habitat (Whitehead, 1992): • $22 per household per year Estimated value of a sea turtle nest (S.C. Statutes § 50-15-30, § 50-15-80): • $1,000/nest
Sand Dunes	Shoreline protection	Not available					Shoreline protection in Isle of Palms, S.C. (Braud, 2018): • $291 per ha in a 100-year storm event
Oyster Reefs	Shoreline protection, nitrogen removal, fisheries production	Not available					Shoreline protection (Grabowski et al., 2012)[D]: • $937 per ha per year Nitrogen removal (Grabowski et al., 2012)[D]: • $4,413 per ha per year Commercial fisheries production (Grabowski et al., 2012)[D]: • $4,493 per ha per year
TOTALS		GDP ($ millions)	Employment		Income ($ millions)		
			Emp	Self-Emp	Wages	GR	
		$4,775.84	81,632	1,599	$2,023.16	$105.62	

Emp = Number of employees; Self-Emp = Number of self-employed workers; GR = gross receipts

[A] Unless otherwise noted, "economic impact" and "economic contribution" estimates consist of total direct, indirect, and induced effects.

[B] Not confined to offshore mining; offshore-specific contributions unavailable. Derived by aggregating IMPLAN codes 30,31,33,35,36,39,40 in Appendix Table 5 of Willis and Straka (2016).

[C] Not confined to offshore mining; offshore-specific contributions unavailable. Derived by aggregating IMPLAN codes 20,37,38 in Appendix Table 5 of Willis and Straka (2016).

[D] Evaluated at the author's reported average values.

scenario and a high supply chain concentration" approach,[18] the offshore wind industry could support an annual average of 847 South Carolina jobs through 2035 (American Jobs Project, 2018). These jobs are based on the development, construction, and operation of offshore wind farms in South Carolina in addition to the manufacturing of material components.

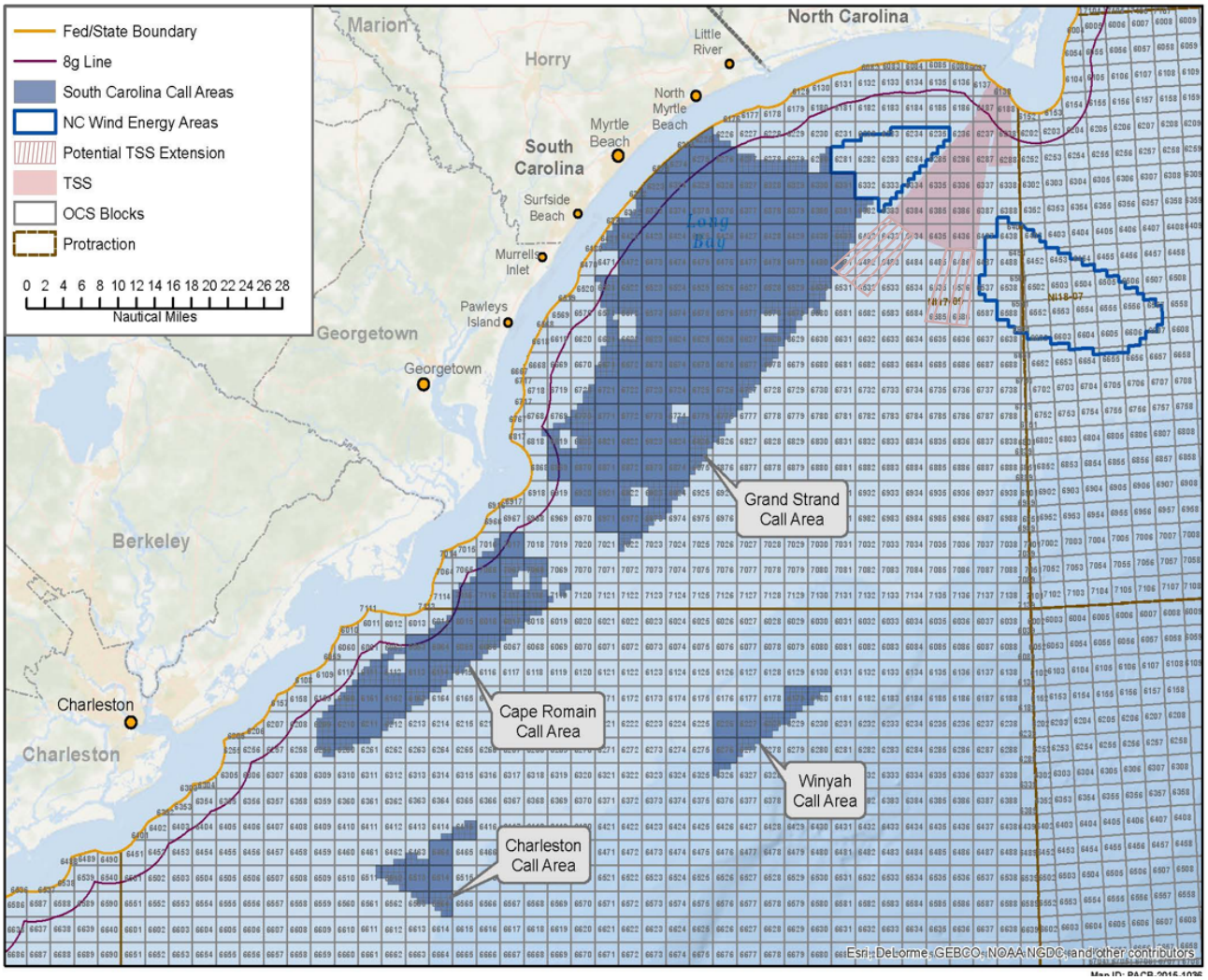


Figure 17: BOEM Wind Energy Call Areas in South Carolina

In a more ambitious hypothetical scenario of constructing, operating, and maintaining 1,000 megawatts (MW) of offshore wind power in the state, Sercy et al. (2014) used a hybrid input-output model and computable general equilibrium model to project the estimated annual economic impact, including direct, indirect, and induced effects, of this hypothetical wind farm. For this analysis, construction and operation were assumed to occur in 2016-2025, and operation and maintenance were assumed to occur in 2026-2030 (Table 12).

[18] Assumes that South Carolina will have an installed wind energy capacity of 300 megawatts (MW) by 2025 and 550 MW by 2030.

Table 12: Projected Annual Economic Impacts of a Hypothetical 1,000 MW Wind Farm in South Carolina (Sercy et al., 2014)

	Construction and Operation (2016-2025)	Operation and Maintenance (2026-2030)
Employment	3,879	678
Personal Income (2017 Dollars)	$209.57 million	$44.63 million
Output (2017 Dollars)	$390.86 million	$122.99 million
Net Government Revenue (2017 Dollars)	$65.77 million	$14.20 million

The estimates in Table 12 also lend context to evaluating the economic trade-offs associated with transitioning toward less consumptive and more sustainable uses of coastal and ocean natural resources. This perspective has gained further traction in an era of climate change and resource scarcity as society attempts to transition to a sustainable Blue Economy. Living marine resources and tourism and recreation are the two sectors most commonly associated with ocean economy activities, and both of these sectors have a rich sociocultural history in South Carolina and will continue to have a place in the state. However, these industries face natural limits on growth based on natural resource availability (e.g., fish and shellfish available for harvest, carrying capacity for visitors).

Construction of offshore wind turbines also has the potential to provide additional co-benefits (i.e., ecosystem services) beyond clean energy. For example, turbines out at sea can act as fish aggregating devices, creating habitat for fish where there previously was none, allowing for additional commercial and recreational fishing opportunities (Fayram and de Risi, 2007; Wilson and Elliott, 2009). Other studies have found that offshore wind turbines can also reduce storm surge and peak wind speeds associated with tropical cyclones (Jacobson et al., 2014), and can even alter the distribution of accumulated precipitation, reducing onshore precipitation downstream of the wind farms (Pan et al., 2018). However, the level of storm and rain impact mitigation services provided by offshore wind turbines will certainly vary with how far turbines are from shore.

Constructed in 2013, Clemson University's Dominion Energy Innovation Center in North Charleston, S.C. is a wind turbine drivetrain testing and grid simulator facility. Coupling this facility's ability to test technology with South Carolina's abundant coastline and shallow waters, the state has great potential for further offshore wind energy development (Oteri et al., 2018). Much of these potential economic benefits of offshore wind energy development remain untapped in South Carolina.

Nature-Based Tourism and Ecotourism

The quality and variety of natural resource assets in South Carolina allow the tourism industry to thrive in the state (Willis and Straka, 2017), and the continued health of the state's natural amenities (both coastal and inland) is necessary to sustain the industry. South Carolina's natural resources provide a wide variety of opportunities for nature-based tourism, a broad term with a debated definition that covers tourism experiences centered on wild or natural environments. A subset of nature-based tourism is ecotourism, defined as non-extractive, minimally invasive, sustainable activities centered around the appreciation of

nature meant to empower host communities that manage the natural areas. Together, the terms encompass everything from fishing and hunting to kayaking and surfing. In terms of nature-based tourism participation, the USFWS conducts a national survey of wildlife-related recreation. The most recent results for wildlife watching in South Carolina indicate that in 2011, 378,000 participants spent 4,254,000 days wildlife watching away from their homes, and spent over $489 million (year 2017 dollars; adjusted with travel price index) in total trip-related and equipment expenses (USFWS, 2014). After 2011, the USFWS discontinued its state-level wildlife-related recreation surveys. Consequently, the participation values reported for wildlife watching are most likely out-of-date relative to 2020.

Duffy et al. (2019) conducted interviews with nature-based tourism providers and tourism destination managers in South Carolina. A key theme that emerged is that nature-based tourism is a part of the culture and history of the state. Major nature-based tourism activities in South Carolina identified in interviews include water-based activities, such as kayaking, canoeing, surfing, stand-up paddleboarding, beach recreation, fishing, crabbing, and shrimping; and non-water-based activities, such as biking, hunting, camping, horseback riding, edible foraging, and concerts/festivals based in outdoor settings. The natural and cultural resources that support these activities include parks and protected areas, beaches, waterfront parks, farms/agriculture, estuaries, lakes, rivers, and the ocean. Infrastructure, such as boat ramps, marinas, docks, and piers, support these activities as well. Using information from these interviews and county-level visitor expenditure data from USTA (2019), Duffy et al. (2020) estimated that between 7-14% of coastal county expenditures are attributable to coastal nature-based tourism. By applying these factors to the amount of visitor expenditures observed in the eight coastal counties derived in USTA (2019), visitors in South Carolina's coastal counties were estimated to have spent between $639.30 million and $1.28 billion (year 2017 dollars; adjusted with travel price index) on nature-based tourism in the year 2018. Duffy et al. (2020) found that these coastal nature-based tourism expenditures led to an estimated total economic contribution, including direct, indirect, and induced effects, of $733.97 million - $1,467.95 million in output, $319.79 million - $639.56 million in income, $543.91 million - $1,087.82 million in contributions to GDP, and 10,576 – 21,152 jobs (year 2017 dollars; adjusted with travel price index).

Besides natural resources, South Carolina's historic and cultural resources along the coast offer nature-based and eco-tourism opportunities to learn about and engage with the state's cultural heritage. For example, the Gullah Geechee Cultural Heritage Corridor, headquartered on Johns Island in Charleston County and stretching the entire coast of the state, continuing north into North Carolina and south into Georgia and Florida, offers visitors a variety of engaging heritage tourism activities, including outdoor music, art, and dance exhibitions, lessons related to traditional rice cultivation along the sea islands, and venues for making traditional sweetgrass baskets. The South Carolina African American Heritage Commission (SCAAHC) lists 108 locations of historic cultural significance within the Corridor (SCAAHC, 2020).

Promoting sustainable nature-based tourism and ecotourism activities can help ensure the viability of South Carolina's natural and cultural resource assets, which help sustain the state's vibrant tourism industry.

Marine Biotechnology

Increasingly, the inherent biological and chemical diversity of our oceans is being harnessed for the production of marine biotechnology and pharmaceuticals (Greco and Cinquegrani, 2016). Technological

advances in ocean exploration and sampling of microscopic compounds coupled with empirical studies on the effectiveness of these compounds has wide-ranging implications for industries, such as aquaculture (e.g., regulating reproduction and sex of species), medicine (e.g., antibiotics and anticancer products), nutrition (e.g., fish oils), and cosmetic (e.g., skin care). In 2018, the global marine biotechnology market size was $3.74 billion (nominal dollars), and it is expected to reach $4.94 billion by the end of 2025 (Trent, 2019). Presently, the lack of information available concerning the marine biotechnology industry in South Carolina suggests there is not a significant level of economic activity for the industry in the state. However, with investment in future research, there is opportunity for marine biotechnology industry growth in South Carolina.

CONCLUSIONS

In 2017, the ocean economy in South Carolina contributed $4.78 billion to state GDP and employed over 12% of all workers in South Carolina's eight coastal counties, with tourism and recreation driving much of the value of the ocean economy in South Carolina. The ocean economy derives value from, and is dependent upon, the health of natural resources in the state, which highlights the importance of natural resource conservation in sustaining and growing the ocean economy. Coupling sustainable economic growth with natural resource conservation in marine settings helps the state work toward a thriving Blue Economy. By applying the Blue Economy concept to policy decisions, policymakers can determine the best courses of action for sustainable economic growth in ocean economy sectors while also enhancing the health of the oceans.

This is especially important given the substantial impact that weather and climate disasters are having on human well-being and business production in the U.S. and abroad. In 2019, there were 14 weather and climate disaster events with losses exceeding $1 billion each across the U.S. (three flooding events, eight severe storm events, two tropical cyclone events, and one wildfire event), resulting in the deaths of 44 people and significant economic effects on the areas impacted. The 1980–2019 national annual average for weather climate events exceeding $1 billion in inflation-adjusted losses was 6.5 events per year; however, the national annual average for the most recent five years (2015–2019) has been 13.8 events per year. Notably, 2019 is the fifth consecutive year in which 10 or more billion-dollar-loss weather and climate disaster events have impacted the U.S., the only such streak of five straight years over the last 40 years (NOAA National Centers for Environmental Information, 2020).

South Carolina has been impacted by tropical cyclones every year from 2015 to 2019 (Hurricane Joaquin, Hurricane Matthew, Hurricane Irma, Hurricane Florence, Hurricane Michael, and Hurricane Dorian), leading to a heightened sensitivity surrounding these events among state residents. The state incurred over $1 billion in economic losses due to weather and climate disasters for each of 2015, 2016, and 2018 (NOAA National Centers for Environmental Information, 2020). The years 2016-2019 each also saw tropical cyclone-driven mandatory evacuation orders issued by the state, leading to more expenses incurred by government (lane reversals, overtime pay), businesses (lost days of operation, reduced customer base), and individuals (fuel, lodging, forgone income). After Hurricane Dorian in 2019, SCPRT estimated that the last five years of hurricanes have led to about $438 million in lost visitor spending (Williams, 2019). Ocean economy sectors are especially vulnerable to coastal hazards like flooding, storms, sea level rise, and erosion; therefore, targeted adaptation strategies are needed to increase the resilience of ocean economy sectors in the face

of climate change. Moreover, while businesses, jobs, and wages are at risk of impacts from weather and climate disasters, the loss of non-market ecosystem service benefits as a result of these events is often overlooked. Therefore, estimates concerning the aggregate economic impacts of climate change (e.g., from flooding, harmful algal blooms, erosion, etc.) may be considerably larger in estimated monetary losses when taking ecosystem services into account (Civantos et al., 2012; van der Geest et al., 2018).

The Organization for Economic Co-operation and Development (OECD) outlines three main recommendations for improving the sustainability of the ocean economy (OECD, 2019):

1. Encourage innovation approaches that produce win-win outcomes for ocean business and the ocean environment,
2. Seek ways to foster the creation and nourish the vitality of ocean-economy innovation networks, and
3. Support new pioneering initiatives to improve measurement of the ocean economy.

The first recommendation addresses how the ocean is being used more intensely than ever before, raising concern about the ability of the ocean's natural capital to persist. As the scientific understanding of the ocean's processes improves, this information needs to be taken into account by businesses that operate in the ocean environment. The second recommendation addresses a multidisciplinary approach for collaboration and information sharing across topical and geographic areas so that the best available biophysical and social science is used, and novel ideas to assess ocean economy trends and ocean health are developed. The third recommendation addresses the pragmatic standardization of how the ocean economy is measured by developing the integration of ocean sectors into national and regional satellite accounts, tracking public investment, and incorporating natural resource values and ecosystem services into assessments of the ocean economy. Regarding the third recommendation, Ocean Economy Satellite Account (OESA) prototype statistics have been recently developed by NOAA and the BEA (NOAA, 2020). The OESA captures additional economic activity that is not easily identified in published data and provides insights into the contribution of the ocean economy to non-ocean sectors (e.g., ports that provide agriculture and manufacturing sectors with access to overseas markets), leading to a better understanding of ocean economy status, trends, and industry linkages. Further, unlike economic impact results, economic contribution direct effects are generally congruent with economic satellite account values (e.g., OESA), which allows for improved comparability between OESA data and other economic contribution studies.

Each of the recommendations can be summarized as promoting the sustainable use of natural resources as economic inputs, and minimizing the adverse impacts that economic outputs may have on these natural resources. By considering and following these recommendations, South Carolina can position itself as a leader in applying the Blue Economy concept to the continued development of the state's coastal- and ocean-dependent industries. Further, as a way to truly apply the Blue Economy concept to ocean economy growth, non-market ecosystem service values must be proactively taken into account when evaluating policy, land use, and marine planning decisions to better comprehend the true societal costs and benefits of these decisions. This necessitates not only an examination and synthesis of what is currently available, but further investments in these types of studies as well so that additional values specific to the state of South Carolina can be derived.

With indicators such as $4.78 billion dollars in ocean economy GDP, $9.13 billion dollars in coastal tourism spending, $38.68 billion worth of cargo value being exported, $51.58 billion worth of cargo value being

imported, $22.78 million in commercial fishery landings, billions of dollars per year in non-market ecosystem service benefits provided by coastal habitats, the coast's rich historic and cultural sites, and the continued growth in ocean economy sectors, South Carolina's ocean economy clearly is of great importance to the past, present, and future of the state.

The coastal population and ocean economy continue to grow in South Carolina. Therefore, the sustainable use of the natural resources that inherently underpin ocean economy activities, and a recognition that these natural resources are "natural capital" which produce a flow of economic benefits, will be paramount as the state moves into the future.

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LIST OF ACRONYMS

BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
BOEM	Bureau of Ocean Energy Management
CPI-U	Consumer Price Index for all Urban Consumers
ECA	Economic Contribution Analysis
EIA	Economic Impact Analysis
ENOW	Economics: National Ocean Watch
EPA	Environmental Protection Agency
GDP	Gross Domestic Product
HA	Hectare
MARAD	United States Maritime Administration
MW	Megawatts
NAICS	North American Industry Classification System
NMFS	National Marine Fisheries Service
NMMA	National Marine Manufacturers Association
NOAA	National Oceanic and Atmospheric Administration
NOEP	National Ocean Economics Program
OCM	Office for Coastal Management
OECD	Organization for Economic Co-operation and Development
OESA	Ocean Economy Satellite Account
SCAAHC	South Carolina African American Heritage Commission
SCDNR	South Carolina Department of Natural Resources
SCPA	South Carolina Ports Authority
SCPRT	South Carolina Department of Parks, Recreation, and Tourism
US	United States
USD	United States Dollars
USFWS	United States Fish and Wildlife Service
USTA	United States Travel Association

APPENDIX A: NAICS CODES FOR ENOW DATA

Table A1: Ocean and Great Lakes Economy Sectors and Industries by NAICS Codes

Sector	Industry	NAICS	NAICS Industry (2012 NAICS)
Living Resources	Fish Hatcheries and Aquaculture	112511	Finfish Farming and Harvesting
		112512	Shellfish Farming
		112519	Other Aquaculture
	Fishing	114111	Finfish Fishing
		114112	Shellfish Fishing
		114119	Other Marine Fishing
	Seafood Processing	311710	Seafood Product and Preparation and Packaging
	Seafood Markets	445220	Fish and Seafood Markets
		424460[1]	Fish and Seafood Merchant Wholesalers[2]
Marine Construction	Marine Related Construction	237990	Other Heavy and Civil Engineering Construction
Marine Transportation	Deep Sea Freight	483111	Deep Sea Freight Transportation
		483113	Coastal and Great Lakes Freight Transportation
	Marine Passenger Transportation	483112	Deep Sea Passenger Transportation
		483114	Coastal and Great Lakes Passenger Transportation
	Marine Transportation Services	488310	Port and Harbor Operations
		488320	Marine Cargo Handling
		488330	Navigational Services to Shipping
		488390	Other Support Activities for Water Transportation
	Search and Navigation Equipment	334511	Search, Detection, Navigation, Guidance, Aeronautical and Nautical System and Instrument Manufacturing
	Warehousing[1]	493110	General Warehousing and Storage
		493120	Refrigerated Warehousing and Storage
		493130	Farm Product Warehousing and Storage

Sector	Industry	NAICS	NAICS Industry (2012 NAICS)
Offshore Mineral Extraction	Limestone, Sand, and Gravel	212321	Construction Sand and Gravel Mining
		212322	Industrial Sand Mining
	Oil and Gas Exploration and Production	211111	Crude Petroleum and Natural Gas Extraction
		211112	Natural Gas Liquid Extraction
		213111	Drilling Oil and Gas Wells
		231112	Support Activities for Oil and Gas Operations
		541360	Geophysical Exploration and Mapping Services
Ship and Boat Building	Boat Building and Repair	336612	Boat Building and Repair
	Ship Building and Repair	336611	Ship Building and Repair
Tourism and Recreation	Boat Dealers	441222	Boat Dealers
	Eating and Drinking Places	722511	Full Service Restaurants
		722513	Limited Service Eating Places
		722514	Cafeterias
		722515	Snack and Nonalcoholic Beverage Bars
	Hotels and Lodging	721110	Hotels (Except Casino Hotels) and Motels
		721191	Bed and Breakfast Inns
	Marinas	713930	Marinas
	Recreational Vehicle Parks and Campsites	721211	RV Parks and Recreational Camps
	Scenic Water Tours	487210	Scenic and Sightseeing Transportation, Water
	Sporting Goods	339920	Sports and Athletic Goods Manufacturing
	Amusement and Recreation Services	487990	Scenic and Sightseeing Transportation, Other
		611620	Sports and Recreation Instruction
		532292	Recreation Goods Rental
		713990	Amusement and Recreation Services Not Elsewhere Classified
	Zoos and Aquaria	712130	Zoo and Botanical Gardens
		712190	Nature Parks and Other Similar Institutions

[1] The 4-digit NAICS codes and supplemented for counties where the 6-digit data are not available.

[2] The fish and seafood merchant wholesalers (424460) industry category is only present for years 2016 and beyond.

Table A2: Ocean and Great Lakes Economy Sectors and Industries by NAICS Codes for Self-Employed Workers

Sector	Industry	NAICS	NAICS Industry (2012 NAICS)
Living Resources	Fishing	1141	Fishing
	Seafood Processing	31171	Seafood Product and Preparation and Packaging
	Seafood Markets	445220	Fish and Seafood Markets
Marine Construction	Marine-Related Construction	237990	Other Heavy and Civil Engineering Construction
Marine Transportation	Marine Passenger Transportation	483	Water Transportation
		486	Pipeline Transportation
		488	Support Activities for Transportation
	Warehousing	4931	Warehousing and Storage
Offshore Mineral Extraction	Limestone, Sand, and Gravel	2123	Nonmetallic Mineral Mining and Quarrying
	Oil and Gas Exploration and Production	2111	Oil and Gas Extraction
		21311	Support Activities for Mining
		541360	Geophysical Surveying and Mapping Services
Ship and Boat Building	Ship and Boat Building and Repair	336	Transportation Equipment Manufacturing
Tourism and Recreation	Boat Dealers	441222	Boat Dealers
	Eating and Drinking Places	7225	Limited Service Eating Places
		722510	Full Service Restaurants
	Hotels and Lodging Places	7211	Traveler Accommodations
		72121	RV Parks and Recreational Camps
		487	Scenic and Sightseeing Transportation

APPENDIX B: ENOW DATA FOR SOUTH CAROLINA'S COASTAL COUNTIES, 2017

*Note that the county totals reported in Appendix B may not add up to the full ocean economy totals reported in Table 2 of the main report. This is due to 1) rounding and 2) confidentiality concerns surrounding publishing business data at smaller scales.

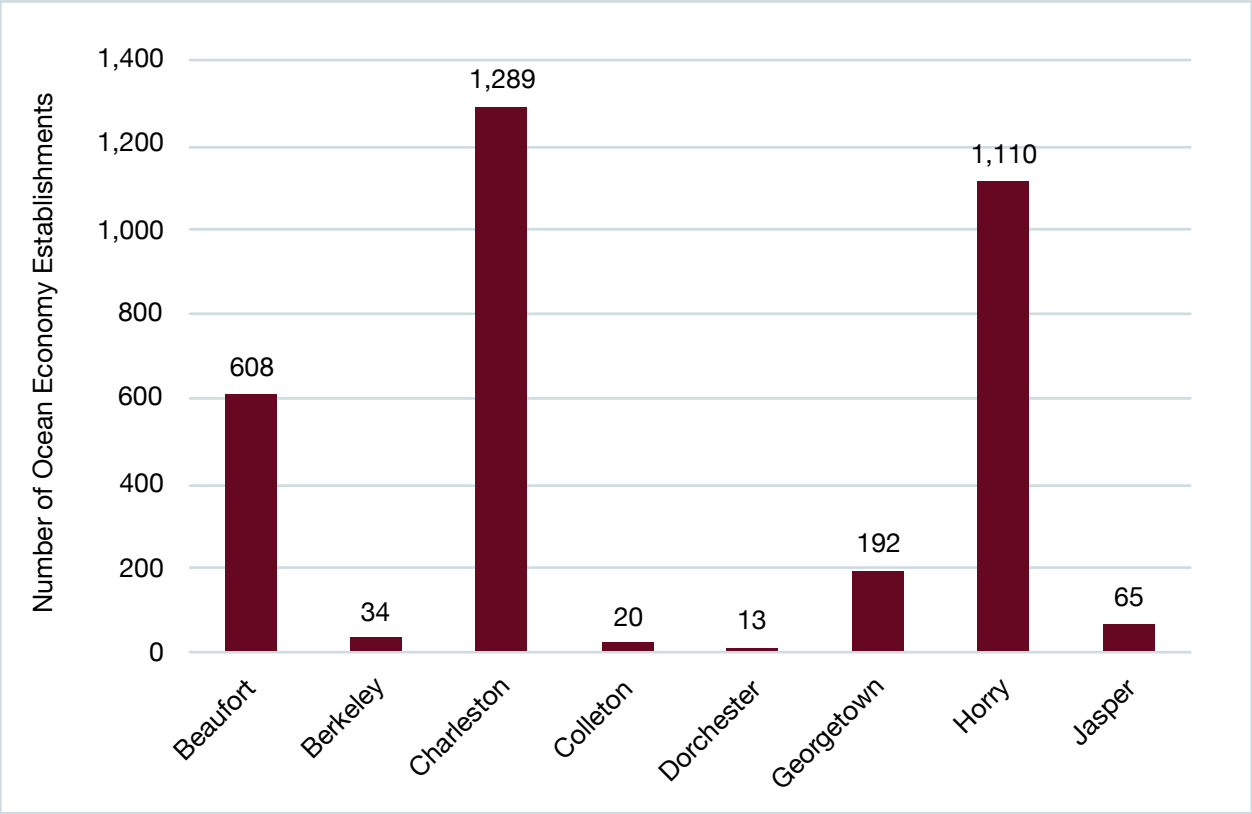

Figure B1: Ocean Economy Establishments in South Carolina's Coastal Counties, 2017

Table B1: Proportion of Establishments Within the Ocean Economy for Each South Carolina Coastal County, 2017

County	Percent of Total Establishments in the Ocean Economy
Beaufort	11.1%
Berkeley	1.2%
Charleston	8.6%
Colleton	2.7%
Dorchester	0.6%
Georgetown	10.4%
Horry	12.7%
Jasper	9.9%

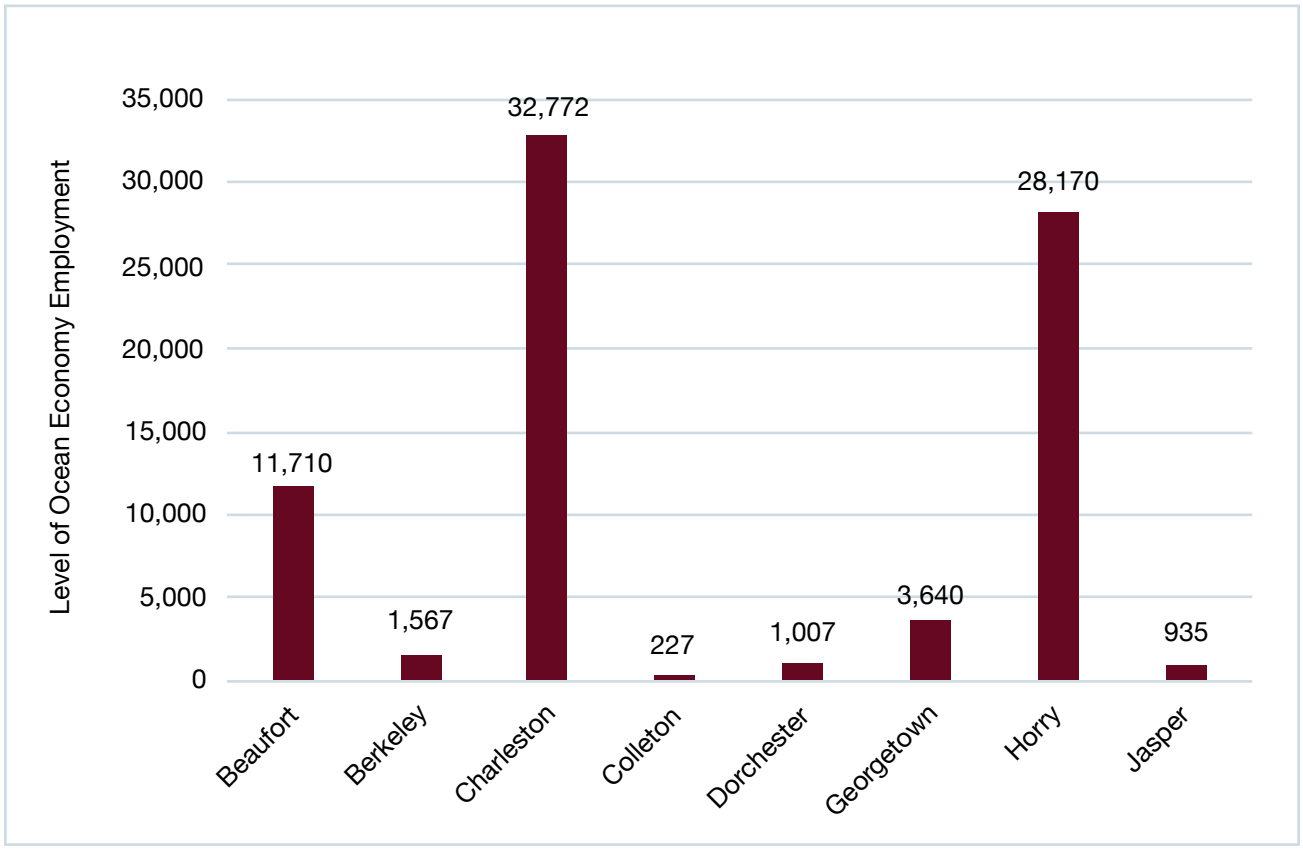

Figure B2: Ocean Economy Employment in South Carolina's Coastal Counties, 2017

Table B2: Proportion of Employment Within the Ocean Economy for Each South Carolina Coastal County, 2017

County	Percent of Total Employment in the Ocean Economy
Beaufort	18.0%
Berkeley	3.1%
Charleston	13.3%
Colleton	2.6%
Dorchester	2.9%
Georgetown	15.6%
Horry	22.2%
Jasper	10.2%

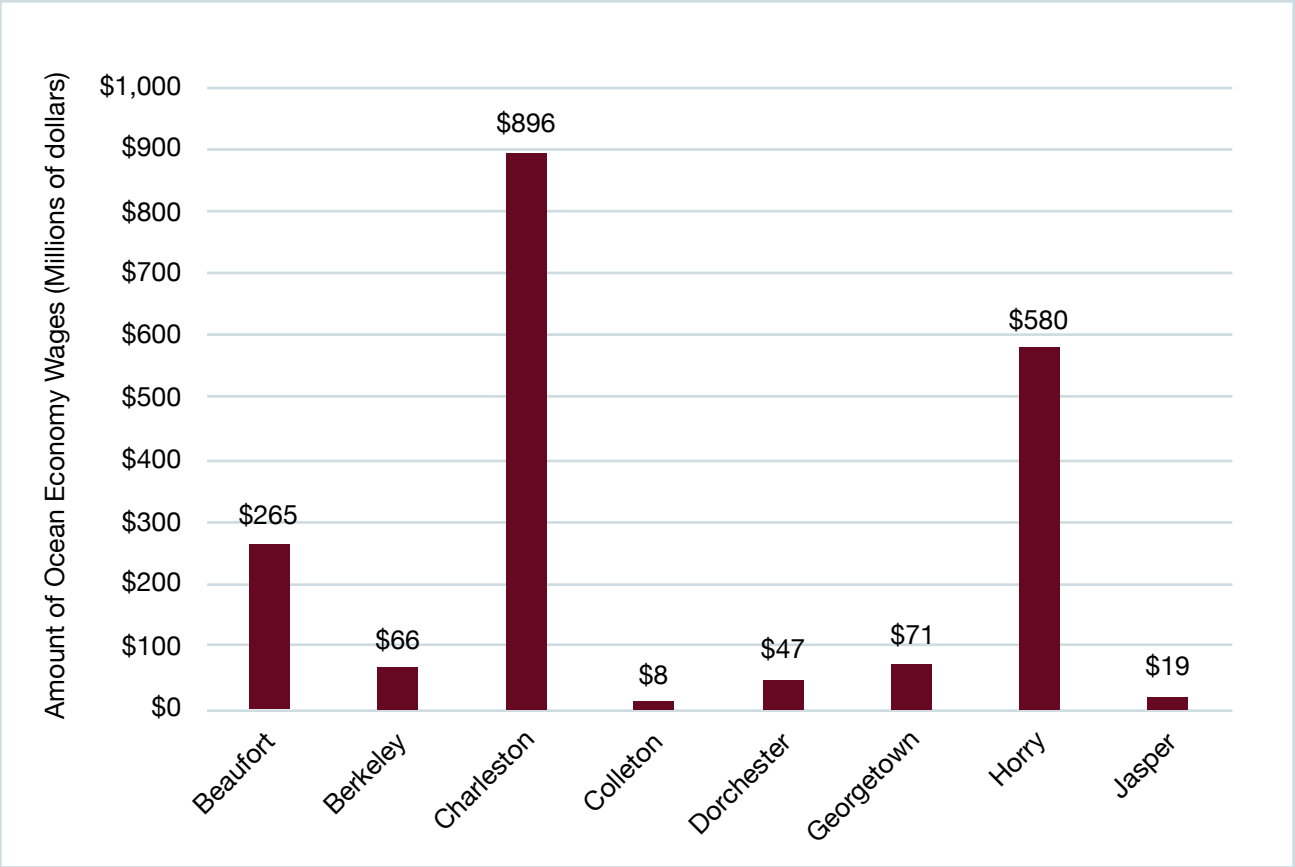

Figure B3: Ocean Economy Wages in South Carolina's Coastal Counties, 2017

Table B3: Proportion of Wages Within the Ocean Economy for Each South Carolina Coastal County, 2017

County	Percent of Total Wages in the Ocean Economy
Beaufort	10.5%
Berkeley	2.6%
Charleston	7.5%
Colleton	2.2%
Dorchester	3.7%
Georgetown	7.8%
Horry	13.7%
Jasper	5.5%

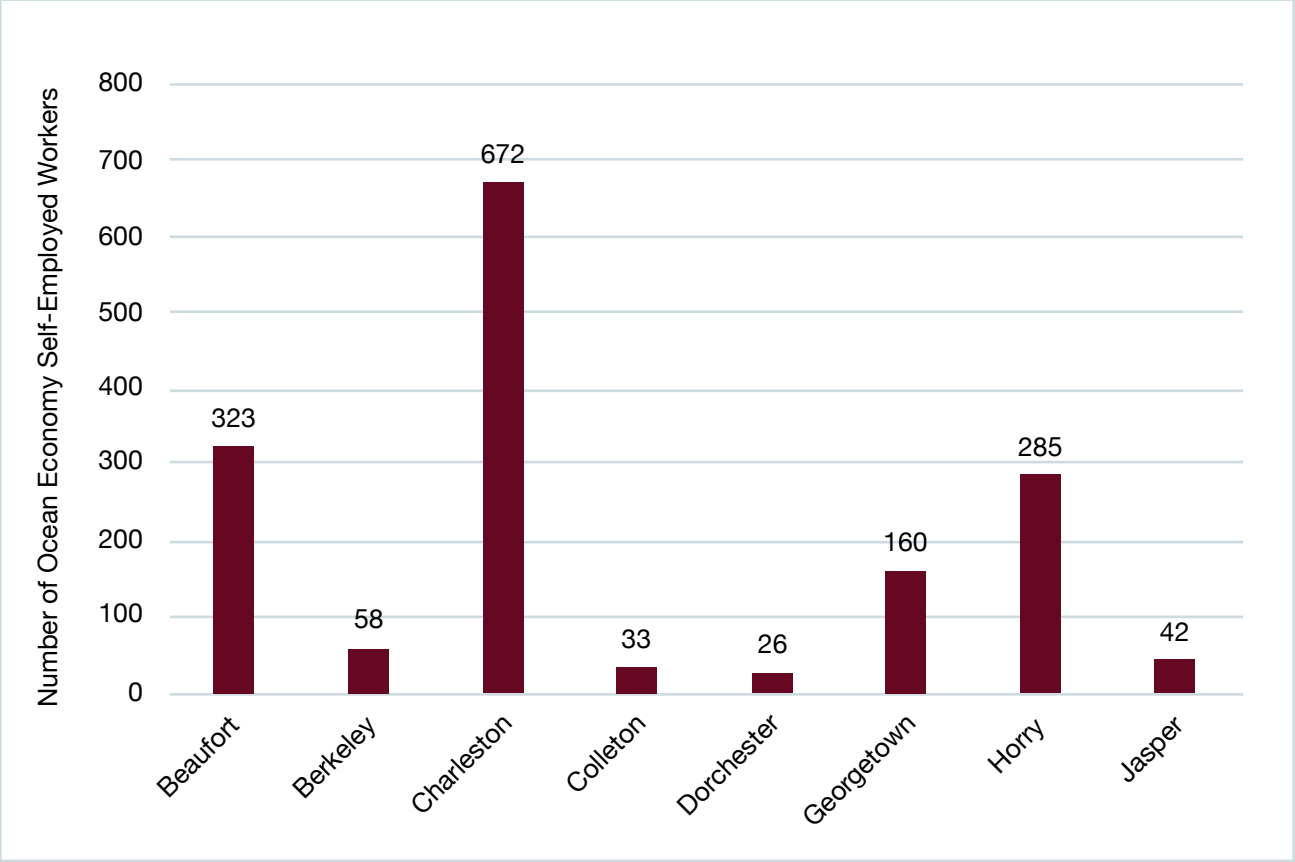

Figure B4: Ocean Economy Self-Employed Workers in South Carolina's Coastal Counties, 2017

Table B4: Proportion of Self-Employed Workers Within the Ocean Economy for Each South Carolina Coastal County, 2017

County	Percent of Total Self-Employed Workers in the Ocean Economy
Beaufort	2.0%
Berkeley	0.4%
Charleston	1.7%
Colleton	1.1%
Dorchester	0.2%
Georgetown	3.0%
Horry	1.1%
Jasper	2.2%

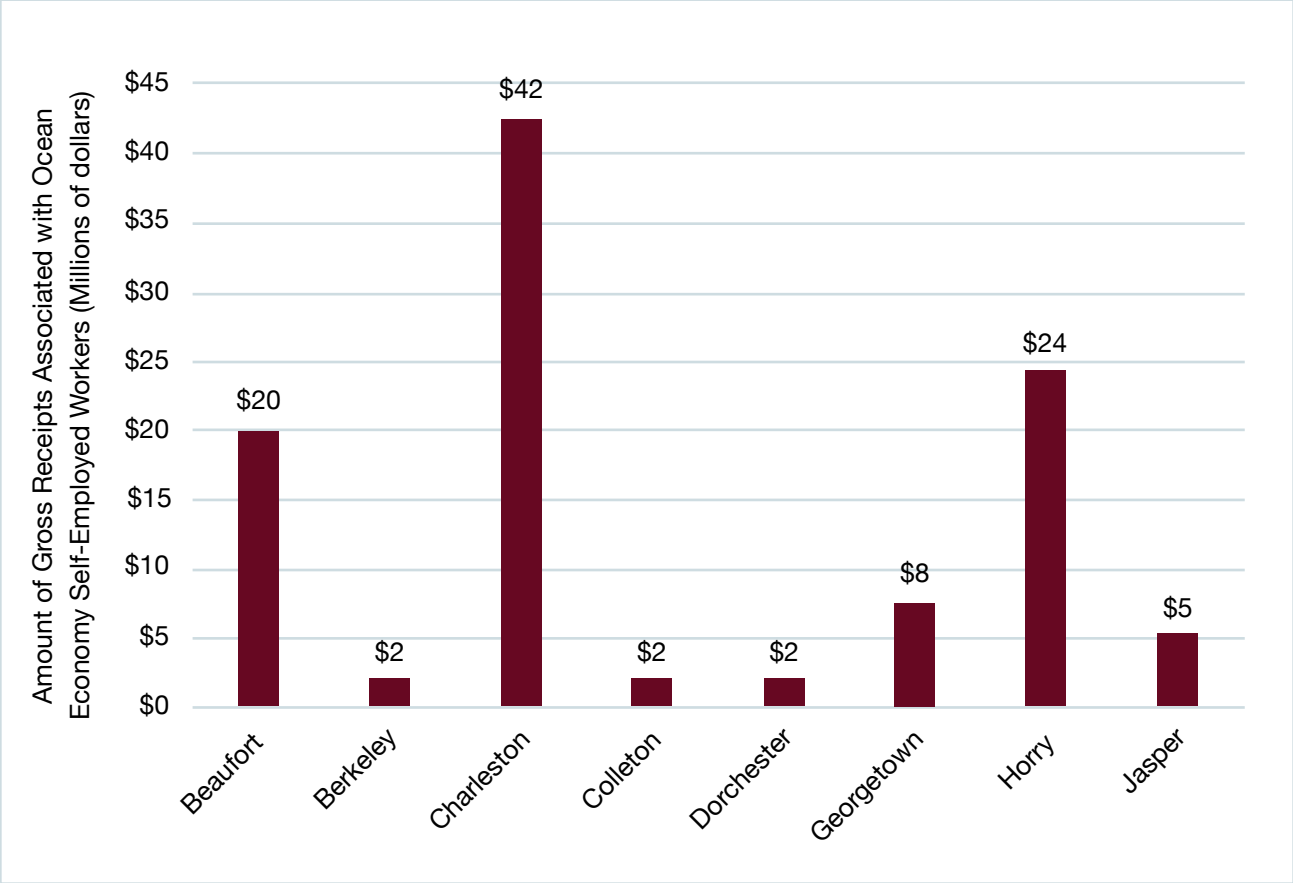

Figure B5: Amount of Gross Receipts Associated with Ocean Economy Self-Employed Workers in South Carolina's Coastal Counties, 2017

Table B5: Proportion of Gross Receipts Associated with Self-Employed Workers Within the Ocean Economy for Each South Carolina Coastal County, 2017

County	Percent of Total Gross Receipts from Self-Employed Workers in the Ocean Economy
Beaufort	2.3%
Berkeley	0.3%
Charleston	2.0%
Colleton	1.6%
Dorchester	0.5%
Georgetown	3.3%
Horry	2.0%
Jasper	6.0%

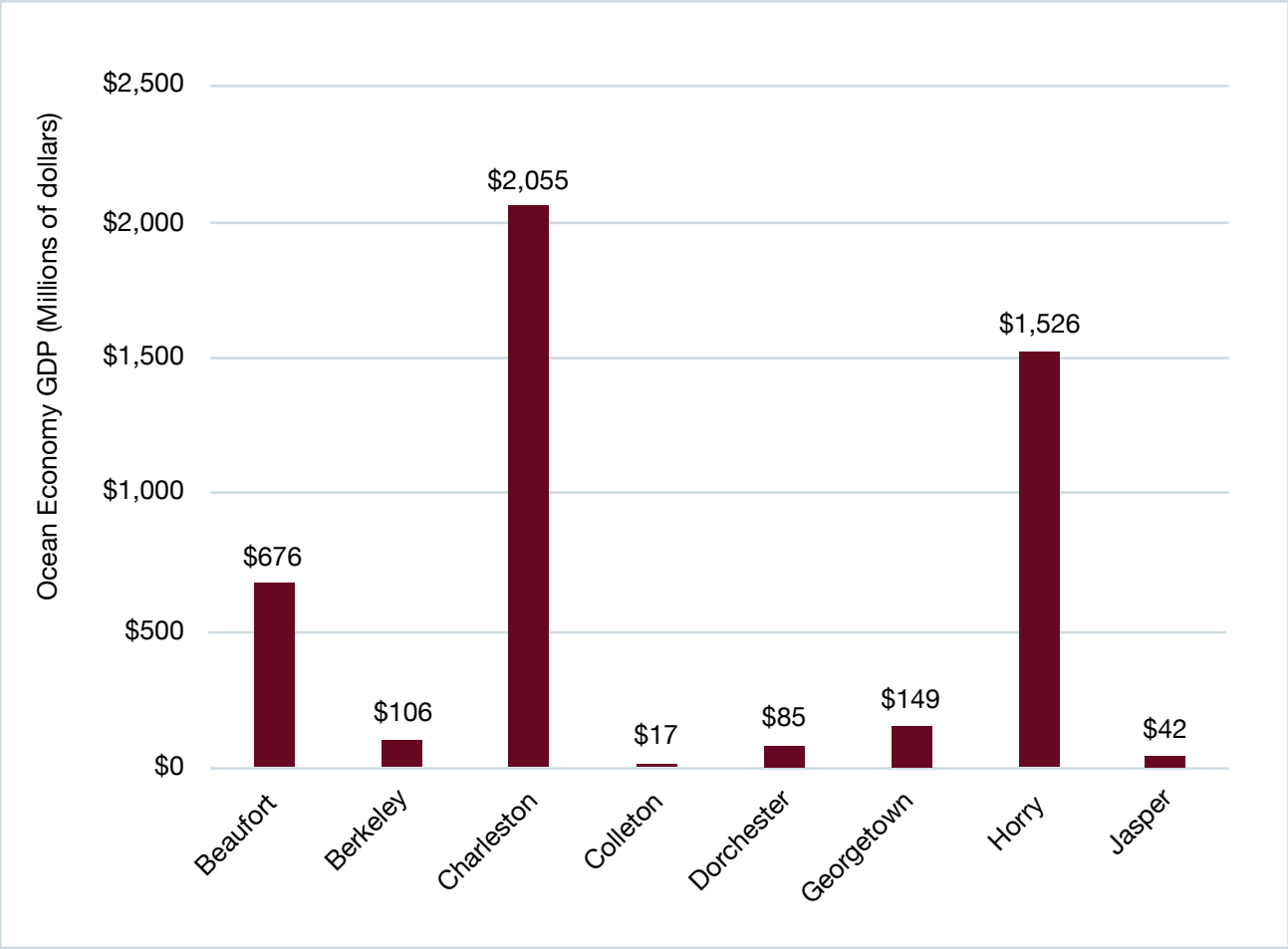

Figure B6: Ocean Economy GDP in South Carolina's Coastal Counties, 2017

Table B6: Proportion of Total GDP Within the Ocean Economy for Each South Carolina Coastal County, 2017

County	Percent of Total GDP in the Ocean Economy
Beaufort	10.3%
Berkeley	1.6%
Charleston	6.6%
Colleton	1.9%
Dorchester	2.6%
Georgetown	6.3%
Horry	13.9%
Jasper	4.7%

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